PROCEEDINGS

OF THE

LITERARY AND PHILOSOPHICAL SOCIETY

OF

LIVERPOOL, Eng. —

DURING THE

SIXTY-FOURTH SESSION, 1874–75.

No. XXIX.

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ORDINARY MEMBERS,

ON THE SOCIETY'S ROLL AT THE CLOSE OF THE 64TH SESSION,

CORRECTED TO JUNE, 1875.

Life Members are marked with an Asterisk.

Oct. 21, 1872 Abbott, Joseph, B.A., *Wavertree Vale, Wavertree-road,* and *Liverpool College, Shaw-street, Everton.*

Oct. 11, 1833 Aikin, James, 4, *Gambier-terrace.*

Nov. 4, 1867 Allen, John Fenwick, *Peasley Vale, St. Helens.*

March 7, 1864 Archer, F., jun., B.A. Trin. Col., Cantab., *Boundary Cottage, Little Crosby.*

*Nov. 28, 1858 Archer, T. C., F.R.S.E., F.R.S.S.A., Director of the Industrial Museum, *Edinburgh.*

Dec. 14, 1868 Ashe, Theop. Fielding, 9–15, *Atherton-street.*

Feb. 22, 1855 Avison, Thomas, F.S.A., 18, *Cook-street,* and *Fullwood Park, Aigburth.*

Jan. 11, 1864 Bagshaw, John, 87, *Church-street,* and 26, *Bentley road, Prince's Park.*

May 4, 1868 Bailey, Fras. J., M.R.C.S., 51, *Grove-street.*

March 28, 1874 Barclay, W., 5, *Scottish Chambers,* 48, *Castle-street,* and 6, *Montpelier-crescent, New Brighton.*

April 20, 1874 Barton, Rev. John, M.A., *Vicarage, Rainhill.*

Jan. 18, 1862 Baruchson, Arnold, *Batavia-buildings, Hackins-hey,* and *The Boltons, Kensington, London.*

Nov. 15, 1869 Beer, Joseph B. de, *Northern Assurance Chambers, Tithebarn-street.*

March 9, 1857 Bell, Christopher, *Redcross-street,* and 55, *Hamilton-square, Birkenhead.*

Jan. 11, 1875 Bell, Wilson, 99, *Chatham-street.*

Feb. 22, 1875 Bellew, Thomas A., *Cunard Mail Office*, 8, *Water-street.*

Dec. 10, 1866 Benas, Baron Louis, 5, *South Castle-street.*

Nov. 14, 1864 Bennett, J. M., *Sir Thomas's-buildings*, and 109, *Shaw-street.*

Nov. 27, 1865 Biggs, Arthur Worthington, 6, *Liver Chambers*, 9, *Tithebarn-street*, and 106, *Bedford-street.*

Feb. 6, 1872 Biggs, John H. W., 6, *Windsor-buildings, George-street.*

Nov. 18, 1867 Biggs, Russell H. W., 8, *Union-street*, and 24, *Canning-street.*

Oct. 31, 1859 Birch, Jas. (Messrs. Reiss Brothers), *The Temple, Dale-street.*

Jan. 25, 1864 Birchall, James, Governor of the Liverpool Industrial Schools, *Kirkdale*, Hon. Secretary.

Dec. 14, 1874 Black, Rev. R., M.A., 26, *Falkner-street.*

Nov. 30, 1874 Bligh, Jno., M.D., 117, *Mount-pleasant.*

March 9, 1866 Blood, William, *Chamber of Commerce*, and *Greta Mount*, 5, *Woodchurch-road, Birkenhead.*

Nov. 26, 1866 Boult, Joseph, 15D, *Exchange-buildings, W.*

*Mar. 6, 1835 Boult, Swinton.

Oct. 19, 1868 Bower, Anthony, *Vauxhall Foundry*, and *Bowersdale, Seaforth.*

Oct. 21, 1872 Bowring, C. T., *Elmsleigh, Prince's Park*, and 20, *Lancaster-buildings, Tithebarn-street.*

Dec. 15, 1873 Brass, Joseph, M.D., 6, *Upper Parliament-street.*

Nov. 4, 1867 Bramwell, Ed., *Cowley Hill, St. Helens.*

Jan. 27, 1873 Bremner, H. H., 15, *Lord-street.*

Nov. 12, 1866 Browne, Edgar A., 86, *Bedford-street, South.*

Oct. 18, 1869 Brown, Dr. J. Campbell, D.Sc., F.C.S., *School of Medicine, Dover-street.*

Feb. 4, 1867 Burden, Edward, 128, *Upper Parliament-street.*

Nov. 12, 1866 Butler, Rev. George, *The College, Shaw-street.*

April 18, 1864 Burne, Joseph, *Royal Insurance Office*, 1, *North John-street*, and *Higher Tranmere.*

*May 1, 1848	Byerley, Isaac, F.L.S., F.R.C.S., *Victoria-road, Seacombe.*
Nov. 8, 1862	Cameron, John, M.D., M.R.C.P., Physician to the Southern Hospital, and Lecturer on Medicine at the Royal Infimary School of Medicine, 17, *Rodney-street.*
Dec. 2, 1872	Carey, Eustace, *Appleton-in-Widnes, near Warrington.*
Jan. 9, 1865	Cariss, Astrup, 40, *Castle-street.*
March 4, 1872	Carter, W., M.B. Lond., 74, *Rodney-street.*
Dec. 2, 1861	Chadburn, William, 71, *Lord-street.*
Feb. 22, 1875	Chapman, Thos., *Oaklynne, Parkfield-road, Prince's-park.*
Jan. 26, 1868	Commins, Andrew, LL.D. Dub., *Eldon Chambers,* 20, *South John-street.*
Nov. 1, 1869	Cook, C. H., *Blundell Sands.*
Jan. 12, 1874	Cook, Edmund Alleyne, Ph.D., F.C.S., (Messrs. Crosfield, Barrow & Co.) 323, *Vauxhall-road.*
Oct. 18, 1869	Cook, Henry James, *Byrom-street,* and *Burbo House, Blundell Sands.*
Oct. 6, 1863	Crosfield, William, Jun., 28, *Temple Court,* and *Alexandra-drive, Ullet-road.*
Feb. 6, 1872	Cudlipp, Ralph B., 57, *Catherine-street.*
Nov. 26, 1866	Curtis, Rev. F. H., M.A. Oxon., *The College, Shaw-street.*
Dec. 14, 1868	Daly, Denis, 11, *Rumford-street.*
Jan. 24, 1870	Dallinger, Rev. W. H., F.R.M.S., 4, *Fairholme-road, Great Crosby.*
Nov. 12, 1866	Davies, E., F.C.S., *The Laboratory, Royal Institution, Colquitt-street.*
Oct. 21, 1872	Davies, Rev. J. Alden, 6, *Newstead-road, Smithdown-lane.*
Nov. 2, 1868	Dawbarn, William, *The Temple, Dale-street,* and *Mossley-hill.*
Oct. 20, 1873	Day, George, 28, *Brunswick-street,* and *Abbey Cottage, Aintree.*

Oct. 1, 1866 Dawson, Thomas, 26, *Rodney-street.*

March 9, 1868 Dixon, W., *Somerville House, Poulton-road, Seacombe.*

April 6, 1874 Dodd, John, 6, *Thomas-street*, and 2, *Derby-terrace, Rock Ferry.*

Nov. 27, 1868 Dove, John M., *Claughton.*

Jan. 28, 1848 Drysdale, John James, M.D. Edin., M.R.C.S. Edin., 36, *Rodney-street.*

Feb. 4, 1856 Duckworth, Henry, F.L.S., F.R.G.S., F.G.S., 32, *Brown's-buildings, Exchange-street, W.*

*Nov. 27, 1848 Edwards, J. B., Ph.D. Gies., F.C.S., Professor Medical Faculty of Bishop's College, *Montreal.*

Mar. 21, 1870 Edwards, Edward E. (Smith, Edwards & Co.), *Adelaide-buildings*, 4, *Chapel-street.*

Feb. 24, 1868 Elliot, John, 35, *Peter's-lane.*

April 7, 1862 English, Charles J., 26, *Chapel-street*, and 26, *Falkner-square.*

April 20, 1874 English, Robert A., 26, *Falkner-square.*

Jan. 12, 1874 Everitt, R., 72, *Chatham-street.*

*Dec. 18, 1852 Ferguson, William, F.L.S., F.G.S., *Kinmundy House, near Mintlaw, N.B.*

Feb. 9, 1868 Finlay, Wm., Senior Mathematical Master, Middle School, *Liverpool College*, and 310, *Shaw-street.*

Oct. 1, 1866 Fletcher, Alfred E., F.C.S., H.M. Inspector of Alkali Works for the Western District, 21, *Overton-street, Edge-hill.*

*Mar. 19, 1855 Ford, James Thomas, 5, *Essex-ct., Temple, E.C.*

Dec. 2, 1872 Forwood, Wm. Bower (Messrs. Leech, Harrison & Forwood), 16, *Queen Buildings*, 11, *Dale-street*, and *Burbo Bank Road, Blundell Sands.*

Nov. 16, 1874 Fothergill, Charles George, *Gambier-terrace.*

Jan. 12, 1874 Frost, John Pownall, 10, *North John-street.*

*Feb. 6, 1854 Gee, Robert, M.D. Heidelb., M.R.C.P., Lecturer on Diseases of Children, Royal Infirmary School of Medicine; Physician, Workhouse Hospital, 5, *Abercromby-square.*

Nov. 3, 1873 Geldart, Rev. E. M., M.A., 8, *Wellfield-place, Peel-street.*

Oct. 19, 1874 Grant, John S., M.C.P., Industrial Schools, 19, *Everton-terrace.*

Dec. 14, 1874 Greaves, Leycester H., *Apsley Villa, Wellington-road, Wavertree.*

Nov. 14, 1858 Greenwood, Henry, 32, *Castle-street*, and *Stanley Park.*

Nov. 16, 1874 Grindley, Benjamin H., 23, *Seel-street.*

Dec. 15, 1873 Grisewood, William, *Queen-street, Liscard.*

Dec. 14, 1874 Gunn, Rev. W. E. B., M.A., 3, *Blackburne-terrace, Blackburne-place.*

Nov. 16, 1874 Guthrie, Malcolm, 31, *Stanley-road, Bootle.*

Feb. 9, 1874 Guy, Rev. Robert E., B.A., *St. Anne's, Edge Hill.*

Jan 22, 1855 Hakes, James, M.R.C.S., Surgeon to the Northern Hospital, 30, *Hope-street.*

Oct. 21, 1872 Halliwell, Joseph, 10, *College-lane.*

*Jan. 21, 1856 Hardman, Lawrence, 85, *Rock Park, Rock Ferry.*

Nov. 15, 1869 Hartwig, Estevan, H. L., 62, *Palmaille, Altona, Hamburg.*

Nov. 30, 1874 Harvey, Henry, M.B., *High-street, Wavertree.*

Feb. 6, 1865 Hassan, Rev. E., *Alma-terrace, Sandown-lane.*

Oct. 21, 1872 Havelaar, Louis Willem, *Lance-lane, Wavertree.*

Nov. 13, 1865 Hayward, John Williams, M.D., 117, *Grove-street.*

Feb. 6, 1865 Hebson, Douglas, 13, *Tower Chambers*, and 58, *Bedford-street South.*

Oct. 19, 1874 Hetherington, J. Newby, 57, *Canning-street.*

Nov. 4, 1872 Hicks, Sibley, F.R.C.S., 2, *Erskine-street.*

Dec. 28, 1846 Higgins, Rev. H. H., M.A. Cantab., F.C.P.S., *Rainhill*, Ex-President.

*Oct. 31, 1836 Higginson, Alfred, M.R.C.S., Surgeon Royal Southern Hospital, 44, *Upper Parliament-street*, Vice-President.

Mar. 22, 1869 Higgin, Thomas, 33, *Tower-buildings*, and *Huyton.*

Feb. 20, 1871 Highfield, Samuel, *Manor-road, Liscard.*

April 29, 1872 Hiles, Joseph (Gholson, Walker & Co.), *National Bank Buildings, Castle-street*, and *Sefton Villas Rice-lane, Walton.*

Nov. 16, 1868 Holden, Adam, 48, *Church-street*, and 2, *Carlton-terrace, Milton-road.*

Oct. 20, 1878 Holland, Edgar S., 70, *Tower-buildings South, Water-street.*

March 9, 1868 Holme, James, 10, *Huskisson-street.*

Nov. 30, 1874 Holme, Rev. Arthur P., *Tattenhall, near Chester.*

*Dec. 14, 1862 Holt, Robert Durning, 6, *India-buildings*, and 29, *Edge-lane.*

*Nov. 13, 1854 Hunter, John, Member Historic Society, Pennsylvania, *Halifax, Nova Scotia.*

Dec. 15, 1878 Hutton, Henry, *Baltic-buildings, Redcross-street.*

Jan. 26, 1857 Hutton, David, 8, *St. George's-crescent*, and 61, *Canning-street.*

*April 29, 1850 Ihne, William, Ph.D., Bonn, *Villa Felseck, Heidelberg*, Ex-President.

Feb. 23, 1857 Imlach, Henry, M.D. Edin., 1, *Abercromby-square.*

Oct. 19, 1874 Imlach, Francis, M.B., 1, *Abercromby-square.*

*Oct. 21, 1844 Inman, Thomas, M.D. Lon., M.R.C.P., Consulting Physician, Royal Infirmary, *Vyvyan terrace, Clifton*, Ex-President.

Nov. 28, 1864 Jeffrey, F. J., *Great George-street.*

Oct. 20, 1878 Johnson, Digby, Royal Insurance Office, *North John-street.*

Mar. 10, 1862 Johnson, Richard, *Queen-buildings*, and *Blundell Sands.*

Jan. 26, 1868 Johnson, Richard C., *Queen-buildings*, and *Blundell Sands*, Hon. Treasurer.

Feb. 24, 1868 Jones, Charles W., 8, *Childwall-road, Wavertree.*

Nov. 26, 1866 Jones, Edward, B.A., 85, *Newstead-road.*

*April 4, 1852 Jones, Morris Charles, F.S.A., F.S.A. Scot., 20, *Abercromby-square.*

Oct. 18, 1869 Jones, Wm. Bolton, 21, *South Castle-street.*

Nov. 30, 1874 Joseph, Rev. Morris, 67, *Canning-street.*

April 20, 1874 Kearney, Rev. T., 7, *Overbury-street.*

Oct. 7, 1872 Kelly, Frederick, *Blundell Sands-road East, Great Crosby.*

Oct. 2, 1865 Kendal, Robinson, 16, *Water-street*, and 178, *Bedford-street.*

Nov. 12, 1866 Kennedy-Moore, Rev. W., M.A., 151, *Canning-street.*

Nov. 15, 1869 King, Jos., 18, *Exchange-alley W.*, and *Trelearen House, Blundell Sands.*

Nov. 1, 1869 Kinsman, W. N., 8, *Derwent-road, Stoneycroft.*

*Jan. 14, 1839 Lassell, William, F.R.SS. L. and E., F.R.A.S., 27, *Milton-street*, and *Wapping.*

Oct. 21, 1844 Lear, John, 14, *Cook-street*, and *Stoneby Cottage, Stoneby Green, New Brighton.*

Nov. 8, 1873 Lee, Hamilton (Messrs. Lee & Nightingale), *North John-street.*

Nov. 8, 1873 Lee, Harold (Messrs. Lee & Nightingale), *North John-street.*

Dec. 11, 1871 Leigh, Richmond, M.R.C.S.E., 2, *Park-road.*

Nov. 16, 1874 Lewtas, John, M.B., 2, *Edge-lane.*

Nov. 2, 1868 Lloyd, James, Vice-Consul, Argentine Confederation, 16, *Wellfield-place, Peel-street, Prince's Park.*

April 17, 1865 MacCheane, Wm., M.R.C S., 47, *Shaw-street.*

April 20, 1868 Marples, David, *Lord-street* and *Cable-street*, and 5, *Mount Grove, Oxton, Birkenhead.*

Nov. 14, 1870 Marples, Joseph, 28, *Leece-street*, and *Fernlee*, 51, *Whetstone-lane, Tranmere.*

Nov. 17, 1873 Marples, Josiah, *Melvill Chambers, Lord-street*, and *Broomfield, Egremont.*

Feb. 9, 1874 Marsden, Peter Crook, *Lymefield, Heaton, near Bolton.*

Feb. 24, 1868 Marsh, John, *Rann Lee, Rainhill.*

Jan. 21, 1839 Martin, Studley, 27, *Brown's-buildings*, and 177, *Bedford-street South.*

Feb. 20, 1871 Mason, Alfred H., F.C.S., 56, *Hanover-street*, and 811, *Upper Parliament-street*.

Nov. 2, 1874 Matheson, Rev. A. Scott, *Dunneyat*, *Stanley-road*, *Bootle*.

Feb. 5, 1844 Mayer, Joseph, F.S.A., F.R.A.S., F.E.S., *Pennant House*, *Lower Bebington*.

Nov. 17, 1873 Mellor, James, Jun., *Sefton House*, *Great Crosby*.

Dec. 14, 1874 Mellor, John, 2, *Church-road*, *Walton*.

Oct. 31, 1859 Moore, Thomas John, Corr. Mem. Z.S., Curator Free Public Museum, *William Brown-street*, VICE-PRESIDENT.

Nov. 15, 1869 Morgan, Alfred, 126, *London-road*, and 2, *Rathbone-terrace*, *Wellington-road*, *Wavertree*, HON. LIBRARIAN.

Jan. 8, 1855 Morton, George Highfield, F.G.S., 122, *London-road*.

April 16, 1849 Moss, Rev. John James, B.A., *Upton*, *Cheshire*.

Oct. 29, 1850 Mott, Albert Julius, 82, *Church-street*, and *Adsett Court*, *Westbury-on-Severn*, PRESIDENT.

April 3, 1854 Mott, Charles Grey, 27, *Argyle-street*, *Birkenhead*, and *Cavendish-road*, *Birkenhead Park*.

Nov. 2, 1868 M'Coskry, W., 14, *Cook-street*.

Mar. 23, 1874 M'Culloch, D. B., 28, *Queen-buildings*, *Dale-street*.

Dec. 14, 1874 Murphy, Martin, F.C.S., *College of Chemistry*, 96 *a*, *Duke-street*.

*Oct. 21, 1867 Muspratt, E. K., *Seaforth Hall*, *Seaforth*.

Oct. 20, 1865 Nevins, John Birkbeck, M.D. Lond., M.R.C.S., Lecturer on Materia Medica, Royal Infirmary School of Medicine, 3, *Abercromby-square*, EX-PRESIDENT.

April 7, 1862 Newlands, A., 8 D, *Exchange-buildings*, and 46, *Catherine-street*.

Feb. 6, 1865 Newton, John, M.R.C.S., 20, *Marmaduke-street*, *Edge Hill*.

Nov. 2, 1868 Norrie, Rev. B. A. W., M.A. Cantab., *Rainhill*.

*Oct. 15, 1855 North, Alfred, 23, *Lansdown-crescent, Notting-hill, London, W.*

Nov. 18, 1861 Nugent, Rev. James, 1, *Hornby-road, Walton.*

Dec. 10, 1866 Owen, Peter (Farnworth & Jardine), *Liverpool and London-chambers.*

Feb. 21, 1870 Packer, James Macnamara, M.D., *Rose Cottage, Poplar Bank, Huyton.*

Nov. 4, 1872 Page, Charles C., 28, *Clarence-street.*

Nov. 2, 1874 Palmer, John Linton, R.N., 46, *Rock Park, Rock Ferry.*

Dec. 15, 1873 Parnell, E. W., 45, *Huskisson-street.*

Nov. 16, 1874 Parratt, John, 68, *Rodney-street.*

Mar. 8, 1869 Parratt, Thomas P., *Silverton, North Crosby-road, Waterloo.*

Jan. 9, 1871 Patterson, John, 16, *Devonshire-road, Prince's Park.*

Feb. 20, 1871 Pendlebury, Richard, B.A., *Fellow of St. John's College, Cambridge.*

Nov. 4, 1861 Philip, Thomas D., 48, *South Castle-street,* and *Holly-road, Fairfield.*

Dec. 28, 1846 Picton, James Alanson, F.S.A., Chairman of the Library and Museum Committee, 11, *Dale-street,* and *Sandy Knowe, Wavertree,* PRESIDENT-ELECT.

Nov. 16, 1874 Pim, Edward, 41, *Tithebarn-street.*

April 30, 1866 Prag, Rev. Jacob, 35, *Mount-street.*

Mar. 18, 1872 Pringle, Adam, *Grove Park.*

Nov. 13, 1871 Proctor, Peter, M.R.C.S., and L.S.A. Lond., 18, *St. James's-road.*

*Jan. 22, 1866 Raffles, William Winter, 54, *Brown's-buildings,* and *Sunnyside, Prince's Park.*

Nov. 12, 1860 Rathbone, Philip H., *Liverpool and London Chambers* (H), and *Greenbank Cottage, Wavertree.*

Mar. 24, 1862 Rathbone, Richard Reynolds, 17, *Lancaster-buildings, Tithebarn-street,* and *Beechwood House, Grassendale.*

*Jan. 7, 1856 Rawlins, Charles Edward, 12, *Rumford-court, Rumford-place*, and *Rock Mount, Rainhill.*

Jan. 9, 1870 Rawlins, Gerald W., *Brook Cottage, Rainhill.*

*Nov. 17, 1851 Redish, Joseph Carter, 6, *Dingle-lane.*

Dec. 12, 1870 Rickard, Wm., LL.D., *Alverton House*, 86, *Upper Parliament-street.*

Jan. 11, 1875 Richardson, Joseph (Messrs. Laces & Co.), *Union-court.*

Nov. 29, 1869 Roberts, Isaac, F.G.S., 26, *Rock Park, Rock Ferry.*

Feb. 4, 1867 Robinson, Joseph F., 1, *Knowsley-buildings, Tithe-barn-street.*

Oct. 4, 1869 Rogers, J. Frederick (Dart & Rogers), *The Temple, Dale-street*, and 8, *Onslow-road.*

April 18, 1854 Rowe, James, 16, *South Castle-street*, and 105, *Shaw-street.*

Jan. 22, 1872 Russell, Edward R., "*Daily Post*," *Lord-street*, and 58, *Bedford-street.*

Feb. 20, 1865 Samuel, Albert H. (Evans, Son and Co.), 56, *Hanover-street*, and *Canning-terrace, Upper Parliament-street.*

April 7, 1862 Samuel, Harry S., 11, *Orange-court*, and 2, *Canning-street.*

Nov. 30, 1874 Samuel, William Hy., 145, *Upper Parliament-street.*

Mar. 19, 1866 Sephton, Rev. John, M.A., *Liverpool Institute.*

Nov. 2, 1868 Sharp, Charles, *Liverpool Institute.*

Nov. 16, 1868 Sheldon, E. M., M.R.C.S., 228, *Boundary-street.*

Oct. 29, 1866 Shimmin, Hugh, 56, *Cable-street*, and *Tue Brook, West Derby.*

Feb. 22, 1875 Silvan-Evan, John Hy., B.A., 65, *Everton Brow.*

Nov. 7, 1864 Skinner, Thomas, M.D. Edin., *Dunedin House*, 64, *Upper Parliament-street.*

Dec. 10, 1866 Smith, Elisha (Henry Nash & Co.), 5, *India-buildings.*

April 4, 1870 Smith, James, 9, *Lord-street*, and *Ribblesdale Villas*, 22, *Merton Road, Bootle.*

Feb. 28, 1863 Smith, J. Simm, Royal Insurance Office, *North John-street.*

Feb. 24, 1862 Snape Joseph, Lecturer on Dental Surgery, Royal Infirmary School of Medicine, 75, *Rodney-street.*

April 20, 1874 Snow, Rev. T., M.A., 55, *Seel-street.*

Nov. 8, 1873 Snowdon, Christopher, H. M. Customs, *Inland Revenue-buildings.*

Nov. 12, 1860 Spence, Charles, 4, *Oldhall-street.*

Feb. 10, 1862 Spence, James, 18, *Brown's-buildings, Exchange,* and 10, *Abercromby-square.*

Nov. 27, 1865 Spola, Luigi, LL.D , 85, *Boundary-lane, West Derby-road.*

Jan. 18, 1868 Stearn, C. H., Bank of England, *Castle-street,* and 8, *Eldon-terrace, Rock Ferry.*

Jan. 9, 1865 Stewart, Robert E., L.D.S., R.C.S., Dental Surgeon, Royal Southern Hospital, and Liverpool Dental Hospital, 87, *Rodney-street.*

Nov. 16, 1874 Stoddart, Alexander, 12, *Mount-street.*

Oct. 18, 1858 Stuart, Richard, 11, *Manchester-buildings,* and *Brooklyn Villa, Breeze Hill, Walton.*

*Feb. 19, 1865 Taylor, John Stopford, M.D., Aberd., F.R.G.S., 1, *Springfield, St. Anne-street.*

Jan. 23, 1843 Taylor, Robert Hibbert, M.D. Edin., L.R.C.S.Ed., Lect. on Ophthalmic Medicine, Royal Infirmary School of Medicine, 1, *Percy-street.*

Nov. 17, 1850 Tinling, Chas., *Victoria-street,* and 29, *Onslow-road, Elm Park.*

Dec. 1, 1851 Towson, John Thomas, F. R. G. S., Scientific Examiner, Sailors' Home, 47, *Upper Parliament-street.*

Jan. 7, 1867 Trimble, Robert, *Cuckoo-lane, Little Woolton.*

*Feb. 19, 1844 Turnbull, James Muter, M.D. Edin., M.R.C.P., Physician Royal Infirmary, 86, *Rodney-street.*

Oct. 21, 1861 Unwin, William Andrew, 11, *Rumford-place.*

Oct. 21, 1844 Vose, James Richard White, M.D. Edin., F.R.C.P., Physician Royal Infirmary, 5, *Gambier-terrace.*

Dec. 2, 1872 Waite, William Henry, D.D.S., L.D.S., 10, *Oxford-street.*

Mar. 18, 1872 Walker, George E., F.R.C.S., 58, *Rodney-street.*

Mar. 18, 1861 Walker, Thomas Shadford, M.R.C.S., 82, *Rodney-street.*

Jan. 27, 1862 Walmsley, Gilbert G., 50, *Lord-street.*

Jan. 9, 1865 Walthew, William, *Phœnix Chambers*, and *Vine Cottage, Aughton.*

Mar. 4, 1872 Ward, Thomas, *Brookfields House, Northwich.*

Dec. 18, 1869 Waterhouse, Harold, 87, *Catherine-street.*

Dec. 2, 1861 Weightman, William Henry, *Minster-buildings, Church-street*, and *Cambridge-road, Seaforth.*

April 7, 1862 Whittle, Ewing, M.D., Lecturer on Medical Jurisprudence, Royal Infirmary School of Medicine, 77A, *Upper Parliament-street.*

Jan. 18, 1868 Whitworth, Rev. W. A., M.A., *Hammersmith.*

Jan. 8, 1872 Williams, Wellington A., 21, *Falkner-street.*

Jan. 11, 1875 Williams, George A., *Lombard Chambers, Bixteth-street.*

Nov. 2, 1874 Wolf, Jas. O. de, (Messrs. T. C. Jones & Co.), 26, *Chapel-street.*

Mar. 18, 1861 Wood, George S. (Messrs. Abraham & Co.), 20, *Lord-street*, and *Bellevue-road, Wavertree.*

Nov. 14, 1870 Wood, John J. (Messrs. Abraham & Co.), 20, *Lord-street.*

Nov. 2, 1874 Young, Henry, *South Castle-street.*

HONORARY MEMBERS.

LIMITED TO FIFTY.

1.—1833 The Right Hon. Dudley Ryder, Earl of Harrowby, K.G., D.C.L., F.R.S., *Sandon Hall, Staffordshire*, and 39, *Grosvenor-square, London, W.*

2.—1836 The Most Noble William, Duke of Devonshire, K.G., M.A., F.R.S., F.G.S., &c., Chancellor of the University of Cambridge, *Devonshire House, London, W.*, and *Chatsworth, Derbyshire.*

3.—1833 Sir George Biddell Airy, Knight, M.A., D.C.L., F.R.S., Hon. F.R.S.E., Hon. M.R.I.A., V.P.R.A.S., F.C.P.S., &c., Astronomer Royal, *Royal Observatory, Greenwich.*

4.—1840 James Nasmyth, F.R.A.S., *Penshurst, Kent.*

5.—1841 Charles Bryce, M.D. Glasg., Fell. F.P.S.G., *Brighton.*

6.—1844 T. P. Hall, *Coggleshall, Essex.*

7.—1844 Peter Rylands, *Warrington.*

8.—1844 John Scouler, M.D., LL.D., F.L.S., *Glasgow.*

9.—1844 Thomas Rymer Jones, F.R.S., F.Z.S., F.L.S., Professor of Comparative Anatomy, *King's College, London.*

10.—1844 Sir Charles Lemon, Bart., M.A. Cantab., F.R.S., F.G.S. *Penrhyn, Cornwall.*

11.—1844 William Carpenter, M.D. Edin., F.R.S., F.L.S , F.G.S., Registrar, *London University.*

12.—1848 Rev. Thomas Corser, M.A., *Strand, Bury.*

13.—1850 Rev. Canon St. Vincent Beechy, M.A. Cantab., *Hilgay Rectory, Downham, Norfolk.*

14.—1851 James Smith, F.R.SS.L. and E., F.G.S., F.R.G.S., *Jordan Hill, Glasgow.*

15.—1851 Henry Clarke Pidgeon, *London.*

16.—1851 Rev. Robert Bickersteth Mayor, M.A., Fell. of St. John's College, Cantab., F.C.P.S., *Rugby.*

17.—1852 William Reynolds, M.D., *Beech Lawn, Mossley Hill, Liverpool.*

18.—1853 Rev. James Booth, LL.D., F.R.S., &c., *Stone, near Aylesbury.*

19.—1857 Thomas Jos. Hutchinson, F.R.G.S., F.R.S.L., F.E.S., H. B. M. Consul, *Callao, Peru.*

20.—1861 Sir William Fairbairn, Bart., LL.D., C.E., F.R.S., *Polygon, near Manchester.*

21.—1861 Rev. Thomas P. Kirkman, M.A., F.R.S., *Croft Rectory, near Warrington.*

22.—1865 The Right Rev. H. N. Staley, D.D., Bishop of Honolulu, *Sandwich Islands.*

23.—1868 Edward J. Reed, C.B., *Hull.*

24.—1865 George Rolleston, M.D., F.R.S., Linacre Professor of Physiology in the University of Oxford, *Oxford.*

25.—1865 Cuthbert Collingwood, M.A. and M.B. Oxon, F.L.S.

26.—1867 J. W. Dawson, LL.D., F.R.S., F.G.S., &c., Principal and Vice Chancellor of McGill University, *Montreal.*

27.—1868 Captain Sir James Anderson, *Atlantic Telegraph Company, London.*

28.—1870 Sir John Lubbock, Bart., M.P., F.R.S., *High Elms, Farnborough, Kent.*

29.—1870 Henry E. Roscoe, F.R.S., Professor of Chemistry in Owens College, *Manchester.*

30.—1870 Professor Joseph Henry, Secretary to the Smithsonian Institute, *Washington, U.S.*

31.—1870 Professor Wyville Thompson, F.R.S., *Belfast.*

32.—1870 Joseph Hooker, M.D., F.R.S., *Royal Observatory, Kew.*

33.—1870 Professor Brown-Séquard, M.D.

34.—1870 John Gwyn Jeffreys, F.R.S., 25, *Devonshire-place, Portland-place, London.*

35.—1870 Thomas H. Huxley, LL.D., F.R.S., Professor of Natural History in the Royal School of Mines, *Jermyn-street*, and 26, *Abbey-place, St. John's-wood, London.*

36.—1870 John Tyndall, LL.D., F.R.S., Professor of Natural Philosophy in the Royal Institution, *London.*

37.—1870 Rev. Christian D. Ginsburg, LL.D., *Binfield, Bracknell, Berks.*

38.—1874 Alexander Agassiz.

39.—1874 Frederick Max Muller, LL.D., Professor of Comparative Philology, *Oxford.*

40.—1874 Sir Samuel W. Baker.

CORRESPONDING MEMBERS.

LIMITED TO THIRTY-FIVE.

1.—1867 Albert C. L. Günther, M.A., M.D., Ph. D., British Museum, Editor of the "Zoological Record."

2.—1867 J. Yate Johnson, *London.*

3.—1867 R. B. N. Walker, *Gaboon, West Africa.*

4.—1868 Rev. J. Holding, M.A., F.R.G.S., *London.*

5.—1868 George Hawkins, *Colombo, Ceylon.*

6.—1868 J. Lewis Ingram, *Bathurst, River Gambia.*

7.—1869 George Mackenzie, *Cebu, Philippine Islands.*

8—1870 Rev. Joshua Jones, D.C.L., King William's College, *Isle of Man.*

9.—1874 Samuel Archer, Surgeon-Major, *Honduras.*

10.—1874 Samuel Booker, *Georgetown, Demerara.*

11.—1874 Coote M. Chambers, *Burrard's Inlet, British Columbia.*

12.—1874 Edwyn C. Reed, *Museo Nacionale, Santiago de Chili.*

13.—1874 Millen Coughtrey, M.D., *New Zealand.*

14.—1875 Robert Gordon, Government Engineer, *British Burmah.*

ASSOCIATES.

LIMITED TO TWENTY-FIVE.

1.—Jan. 27, 1862 Captain John H. Mortimer, "America," (Atlantic.)

2.—Mar. 24, 1862 Captain P. C. Petrie, "City of London," Commodore of the Inman Line of American Steam Packets. (Atlantic.)

3.—Feb. 9, 1863 Captain James P. Anderson, R.M.S.S. "Africa," Cunard Service. (Atlantic.)

4.—Feb. 9, 1863 Captain John Carr (Bushby & Edwards), ship "Scindia." (Calcutta.)

5.—Feb. 9, 1863 Captain Charles E. Price, R.N.R. (L. Young & Co.), ship "Cornwallis." (Calcutta and Sydney.)

6.—April 20, 1863 Captain Fred. E. Baker, ship "Niphon." (Chinese Seas.)

7.—Oct. 31, 1864 Captain Thomson, ship "Admiral Lyons." (Bombay.)

8.—Oct. 31, 1864 Captain Alexander Browne (Papayanni), S.S. "Agia Sofia." (Mediterranean.)

9.—April 18, 1865 Captain Alexander Cameron (Boult, English & Brandon), ship "Staffordshire." (Shanghai.)

10.—Dec. 11, 1865 Captain Walker, ship "Trenton."

11.—Mar. 23, 1868 Captain David Scott.

12.—Oct. 5, 1868 Captain Cawne Warren.

13.—Oct. 5, 1868 Captain J. A. Perry.

14.—Mar. 22, 1869 Captain Robert Morgan, ship "Robin Hood."

15.—April 29, 1872 Captain J. B. Walker, Old Calabar.

16.—April 29, 1872 Captain Alfred Horsfall, S.S. "Canopus."

LIBRARY.

DONATIONS DURING THE SESSION.

1874.

DATE ANNOUNCED.	DONORS.
OCTOBER 19th.	
Geological Survey of India: Memoirs, vols. 1-9; Records, vols. 1-6. Palæontologia Indica (4to), series 1-8. Calcutta.	*Governor General and Council.*
Académie Royal des Sciences de Belgique: Bruxelles. Bulletin, 85 and 86, 1878; Annuaire, 1874	*The Academy.*
Annual Report of the Massachusetts Board of State Charities, for 1872-8, Boston, 1874 .	*The Board.*
Annual Report of the Massachusetts Board of Education, for 1872-8, Boston, 1874 . .	*The Board.*
Annual Report of the Massachusetts Board of Agriculture, for 1878, Boston, 1874 . .	*The Board.*
Report for 1872-8, and Catalogue, 1878-4, of Harvard University, Cambridge, Massachusetts	*The University.*
Museum of Comparative Zoölogy, Cambridge, Massachusetts; Illustrated Catalogue (4to): i. Ophiuridæ and Astrophytidæ—T. Lyman, 1864; ii. North American Acalephæ—Alex. Agassiz, 1865; iii. North American Astacidæ—Dr. Hagen, 1871; iv. Deep-Sea Corals—L. F. de Pourtalis, 1871; v. Immature Odonata—L. Cabot, 1871; vi. Supplement to No. i.—T. Lyman, 1871; vii. Revision of the Echini—Alex. Agassiz, 1872-4; Bulletin, vols. 1 and 2, 1868-71; Report, 1868-78 .	*The Museum.*

Bulletin of the Essex Institute, Salem, Massachusetts, vol. 5, 1873	*The Institute.*
Memoires de la Société Imperiales des Sciences Naturelles de Cherbourg, tome 18, 1874 .	*The Society.*
Proceedings of the Academy of Natural Sciences, Philadelphia, 1873	*The Academy.*
Journal of the Franklin Institute, Philadelphia, vol. 68, 1874	*The Institute.*
Report of the Zoological Society of Philadelphia, 1873-4	*The Society.*
Royal Geographical Society, London: Journal, vol. 43, 1873; Proceedings, vol. 18, 1873-4	*The Society.*
Proceedings of the Royal Society of Edinburgh, 1872-3	*The Society.*
Literary and Philosophical Society of Manchester; Proceedings, vols. 8-13, 1869-74: Memoirs, vol. iv., N. S., 1871 . . .	*The Society.*
Proceedings, Bristol Naturalists' Society, 1874	*The Society.*
The Quarterly Journal of Science, to date .	*The Editor.*
"Nature," to date	*The Editor.*
"Science Gossip," to date	*The Editor.*

NOVEMBER 2nd.

Oversigt over det Kongelige Danske Videnskabernes Selskabs Forhandlinger og dets Medlemmers Arbejder, 1873-4 . . .	*The Academy.*
Journal of the Canadian Institute, Toronto, vol. 14, Nos. 2 and 3, 1874 . . .	*The Institute.*
Proceedings of the American Academy of Arts and Sciences, Boston, for 1873 . . .	*The Academy.*
Proceedings of the Society of Natural History, Boston, vol. 16, 1873-4	*The Society.*
Report of the Astor Library, New York, 1874	*The Library.*
Annals of the Lyceum of Natural History, New York, vol. 10, parts 8 to 11, 1873 . .	*The Lyceum.*

Transactions of the American Philosophical Society, Philadelphia (4to), vol. 14, 1870 . *The Society.*

Bulletin of the United States Geological Survey, No. 2, Washington, 1874 . . . . *Dr. Hayden.*

Observations made during 1871, at the United States Naval Observatory, Washington, 1873 . . . . . *The Superintendent.*

Report of the United States War Department, 8 vols., Washington, 1873 . . *The Secretary of War.*

Journal of the Royal Institution of Cornwall, vol. 15, Truro, 1874 . . . *The Institution.*

Report of the Plymouth Institute, 1873-4, Falmouth . . . . *The Institute.*

Proceedings of the Liverpool Philomathic Society, 1873-4 . . . . . *The Society.*

Report of the Microscopical Society, Liverpool, 1873-4 . . . . *The Society.*

Report of the Philosophical and Literary Society, Leeds, 1872-4 . . . . *The Society.*

Report of the Literary and Philosophical Society, Hull, 1873-4 . . . . *The Society.*

Proceedings of the Philosophical Society, Glasgow, vol. 9, part 1, 1873-4 . . . *The Society.*

Transactions of the Geological Society, Edinburgh, 1873-4 . . . . . . *The Society.*

Proceedings of the Botanical Society, Edinburgh, vol. 11, part 3, 1874 . . . . *The Society.*

Report of the Literary and Scientific Society, Birkenhead, 1873-4 . . . . . *The Society.*

Proceedings of the Berwickshire Naturalists' Club, 1873, Alnwick . . . . *The Club.*

Proceedings of the Natural History and Philosophical Society, Belfast, 1872-4 . . . *The Society.*

NOVEMBER 16th.

The Bakerian Lecture—"On the Structure and Development of the Skull in Salmon (*Salmo Salar*)," by W. Kitchen-Parker, F.R.S. . *The Author.*

Brief Sketches of the Parishes of Booterstown and Donnybrook, by Rev. B. H. Blacker, M.A., Dublin, 1874 . . . . . . *The Author.*

Algebra Identified with Geometry, by Alex. J. Ellis, F.R.S., London, 1874 . . . *The Author.*

Ænidea, vol. 1, by James Henry, M.D., Dublin, 1874 . . . . *The Author.*

Journal of the Meteorological Society of Scotland, nos. 41 and 42, Edinburgh, 1874 . *The Society.*

Proceedings of the Naturalists' Society, Bristol, 1873 . . . . *The Society.*

Proceedings of the Natural History Society, Bath, vol. 3, part 1, 1874 . . . *The Society.*

Proceedings of the Zoological Society, London, 1874, parts 1 and 3 . . . . . *The Society.*

Journal of the East Indian Association, London, vol. 8, parts 1 and 2, 1874 . . *The Association.*

Transactions of the Royal Medico-Chirurgical Society, London, vol. 57, 1874 . . . *The Society.*

Proceedings of the Royal Institution, London, vol. 8, parts 3 and 4, 1874 . . *The Institution.*

Proceedings of the Royal Society, London, nos. 151 and 154, 1874 . . . . *The Society.*

Journal of the British Meteorological Society, London, vol. 2, parts 9 and 11, 1874 . *The Society.*

Journal of the Linnæan Society, London: Botany, nos. 73–76, 1873-4; Zoology, no. 57 . . . . *The Society.*

Proceedings of the Geologists' Association, London, vol. 3, parts 5-7, 1873-4 . *The Association.*

Journal of the Geological Society, London, February to August, 1874 . . . *The Society.*

Journal of the Chemical Society, London, nos. 135-141, 1874 . . . . *The Society.*

Monthly Notices of the Royal Astronomical Society, London, March to July, 1874 . *The Society.*

The Quarterly Journal of Science, London, October, 1874 . . . . . . *The Editor.*

NOVEMBER 30th.

Transactions of the Royal Society of Victoria, vol. 10, 1869-72, Melbourne, 1873 . . *The Society.*

Mittheilungen der Geographischen Gesellschaft, Vienna, 1873 . . . . . . *The Society.*

The Works of Count Rumford, vols. 2 and 3, Boston, 1873 . . *The American Academy of Arts and Sciences, Boston.*

Memoirs of the Boston Society of Natural History: i. On the early stages of *Terebratulina Septentrionalis*, by E. S. Morse, Ph. D., Boston, 1871; ii. On the Osteology and Myology of *Didelphis Virginiana*, by Elliott Coues, M.D., Boston, 1872, with an Appendix, On the Brain, by J. Wyman, M.D., 1872; iii. On the Development of *Limulus Polyphemus*, by A. S. Packard, M.D., Boston, 1872; iv. On the Birds of West and North-West Mexico, by George N. Lawrence, Boston, 1874 *The Society.*

Annual Report of the Massachusetts Board of State Charities, vols. 3-8, Boston, 1867-71 *The Board.*

Proceedings of the Asiatic Society of Bengal, nos. 1-8, January to July, 1874 . . . *The Society.*

Transactions of the American Philosophical Society (4to), N. S., vol. 15, part 1, 1873 . *The Society.*

Synopsis of the Flora of Colorado (U. S. Geological Survey), by T. C. Porter and J. M. Coulter. . . . . *Dr. Hayden.*

Proceedings of the Royal Asiatic Society, London, vol. 7, part 1, 1874 . . . . *The Society.*

Proceedings of the Society of Antiquaries, London, vol. 6, parts 1-3, 1873-4 . . . *The Society.*

Journal of the Chemical Society, London, October, 1874 . . . . . . *The Society.*

Proceedings of the Geologists' Association, London, vol. 3, part 3, 1874 . . *The Association.*

Journal of the Linnæan Society, London: Botany, no. 77, and Zoology, no. 58, November, 1874 . . . . . *The Society.*

Proceedings of the Numismatic Society, Liverpool, no. 3, 1873–4 . . . . . *The Society.*

FEBRUARY 8th.

On the Natural History and Distribution of Yellow Fever in the United States from 1668 to 1874, with Chart, &c., by J. M. Toner, M.D., Washington, 1874 . . . . *The Author.*

On the Diurnal Inequalities of the Barometer and Thermometer, by W. W. Rundell, F.M.S., London, 1874 . . . . . . *The Author.*

Proceedings of the American Academy of Arts and Sciences, New Series, vol. 1, Philadelphia, 1873–4 . . . . . . *The Academy.*

Bulletin of the Museum of Comparative Zoology, Cambridge, Mass., vol. 3, parts 1-10, 1871–3 *The Society.*

Journal of the Asiatic Society of Bengal, Calcutta, 1873-4 . . . . . . *The Society.*

Bulletin of the Essex Institute, Salem, Mass., vol. 5, 1873 . . . . . . *The Institute.*

Journal of the Franklin Institute, Philadelphia, vol. 68, 1874 . . . . . . *The Institute.*

Report of the Pennsylvanian Board of Education for 1873, Philadelphia, 1874 . . *The Board.*

Report of the Department of Agriculture (U. S. Government) for 1873, Washington . *The Commissioner.*

Report of the Yorkshire Philosophical Society, 1873, York . . . . . *The Society.*

Report of the Free Public Library of Manchester, 1873-4 . . . . . . *The Committee.*

Abstract Proceedings of the Liverpool Geological Society, 1873-4 . . . . . *The Society.*

Transactions of the Historic Society of Lancashire and Cheshire, 1873-4 . . . *The Society.*

Proceedings of the Royal Society, nos. 155 and 156, London, 1874 . . . . *The Society.*

Quarterly Journal of the British Meteorological Society, October, 1874, London . . . *The Society.*

Journal of the Chemical Society, London, November and December, 1874 . . . *The Society.*

Monthly Notices of the Royal Astronomical Society, London, November and December, 1874 . . . . *The Society.*

"Nature," to date . . . . *The Editor.*

"Quarterly Journal of Science," to date . . *The Editor.*

"Science Gossip," to date . . . . *The Editor.*

FEBRUARY 22nd.

Journal of the Anthropological Institution, no. 10; London, 1874 . . . . *The Institution.*

Journal of the Chemical Society, London, January, 1875 . . . . . . *The Society.*

Proceedings of the Royal Geographical Society, vol. 19, part 1, London, 1875 . . . *The Society.*

Journal of the Geological Society, vol. 30, parts 4-15, London, 1874 . . . *The Society.*

Proceedings of the Geologists' Association, London, January, 1875 . . . *The Association.*

Journal of the Linnean Society (Botany), no. 78, London, 1875 . . . . . *The Society.*

Transactions of the Royal Society of Literature, vol. 10, part 3, London, 1874 . . *The Society.*

Quarterly Journal of the Statistical Society, vol. 37, London, 1874 . . . . . *The Society.*

Almanack of the Statistical Society for 1875, and Index of the Statistical Society's Journal, 1868–72 . . . . . . *The Society.*

Proceedings of the Royal Irish Academy, vol. 2, N.S., part 1, Dublin, 1875 . . . *The Academy.*

Greenwich Observations, 1872, and Cape Catalogue of Stars . . . . . *The Admiralty.*

Proceedings of the Philosophical Society of Glasgow, November, 1874 . . . . *The Society.*

Report of the Literary and Philosophical Society of Whitby, 1874 . . . . . . *The Society.*

Smithsonian Contributions to Knowledge, vol. 19 (4to.), Washington, 1874 *The Smithsonian Institution.*

Report of the Exploration of the Colorado of the West, by Professor Powell, Washington, 1874 . . . . *The Smithsonian Institution.*

Report of the Commissioner of the Department of Agriculture, Washington, for 1872 . *The Commissioner.*

Proceedings of the American Philosophical Society, nos. 91 and 92, Philadelphia, 1874 . . . . *The Society.*

Palæontologia Indica (4to.), series 9, part 1, of the Geological Survey, Calcutta, 1873 *The Governor-General and Council.*

Memoirs of the Geological Survey of India, vol. 10, part 1, Calcutta, 1874 . . *The Governor-General and Council.*

Proceedings of the Asiatic Society of Bengal, August, 1874 . . . . *The Society.*

Report of the British Association, Bradford Meeting, 1873 . . . . *Dr. Inman.*

"Nature" to date . . . . . . *The Editor.*

"Journal of the Society of Arts, London," to date . . . . *The Editor.*

MARCH 8th.

Monthly Notices of the Royal Astronomical Society, vol. 35, no. 3, London, January, 1875 . . . . *The Society.*

Proceedings of the Royal Society, no. 158, London, December, 1874 . . . . *The Society.*

Minutes of Proceedings, Royal Irish Academy, Dublin, November, 1874 . . . . *The Academy.*

Proceedings of the Philosophical Society of Glasgow, 14th December, 1874 . *The Society.*

Proceedings of the American Association for the Advancement of Science, First Meeting, Philadelphia, 1848, and of the Twenty-second Meeting, Portland, Me., 1873 . *The Association.*

Journal of the Franklin Institute of Philadelphia, January, 1875 . . . . *The Institute.*

Report of the Smithsonian Institution for 1872, Washington . . . . . . *The Institution.*

Smithsonian Miscellaneous Collections, vols. 11 and 12, Washington, 1874 . . . . *The Editor.*

"Nature," to date . . . . . . *The Editor.*

"Journal of the Society of Arts," to date . *The Editor.*

MARCH 22nd.

Journal of the Asiatic Society of Bengal, part 2, no. 2, Calcutta, 1874 . . . . . *The Society.*

Journal of the Franklin Institute of Philadelphia, February, 1875 . . . . . *The Institute.*

Journal of the Chemical Society, no. 146, London, February, 1875 . . . . . *The Society.*

Journal of the Geological Society, vol. 31, part 1, February, 1875 . . . . . . *The Society.*

Journal of the Meteorological Society, no. 13, London, January, 1875 . . . . . *The Society.*

Proceedings of the Royal Society, no. 158, London, January, 1875 . . . . . *The Society.*

Journal of the East Indian Association, vol. 8, part 3, London, 1875 . . . . *The Association.*

Journal of the Royal Geological Society of Ireland, vol. 4, part 1, Dublin, 1874 . . *The Society.*

Proceedings of the Botanical Society, vol. 12, part 1, Edinburgh, 1874 . . . . . *The Society.*

Proceedings of the Royal Society of Edinburgh, 1873-74 . . . . *The Society.*

Report of the Royal Cornwall Polytechnic Society for 1873, Falmouth, 1874 . . . *The Society.*

Proceedings of the Geological and Polytechnic Society of the West-Riding of Yorkshire, 1871-2, Leeds, 1874 . . . . . . *The Society.*

Transactions of the Natural History Society of Northumberland and Durham, vol. 6, Newcastle, 1874 . . . . *The Society.*

Report of the Literary and Philosophical Society and Town Museum, Leicester, 1874. *The Society.*

"Science Gossip," to date . . . . . *The Editor.*

"Nature," to date . . . . . . *The Editor.*

"Journal of The Society of Arts," to date . *The Society.*

APRIL 19th.

Mémoires de la Société des Sciences Physiques et Naturelles de Bordeaux, Tome i, 2e Série 1er Cahier, 1875 . . . . . . *The Society.*

Proceedings and Journal of the Asiatic Society of Bengal, Calcutta, 1874-5 . . . . *The Society.*

Journal of the Bombay Branch of the Royal Asiatic Society, 1873-4 . . . . . *The Society.*

Monthly Notices of the Royal Astronomical Society, London, Feb. and Mar., 1875 . *The Society.*

Journal of the Chemical Society, no. 147, London, March, 1875 . . . . . *The Society.*

Proceedings of the Royal Geographical Society of London, nos. 2 and 3, 1875 . . . *The Society.*

Report of the Geologists' Association, London, 1874 . . . . *The Association.*

Proceedings of the Royal Society, no. 159, London, 1875 . . . . *The Society.*

Journal of the East Indian Association, vol. 8, part 3, London, 1875 . . . . *The Association.*

Guide to Belfast, 1874 . . *The Belfast Naturalists' Field Club.*

Transactions of the Geological Society of Glasgow, vol. 5, part 1, 1875 . . . . *The Society.*

Journal of the Polytechnic Society of Liverpool for 1871-3, in 1 vol. . . . . . *The Society.*

Report of the Ashmolean Society, Oxford, 1873-4, with an Obituary Notice of Prof. Phillips, 1874 . . . . *The Society.*

Journal of the Society of Arts, London . . *The Society.*

"Nature," to date . . . . . . *The Editor.*

"Science Gossip," to date . . . . . *The Editor.*

"Quarterly Journal of Science," to date . . *The Editor.*

Ancient Pagan and Modern Christian Symbolism, by Dr. Inman . . . . . . *The Author.*

LIST OF SOCIETIES, ACADEMIES, INSTITUTIONS, Etc.,

TO WHICH THIS VOLUME IS PRESENTED.

(*The Asterisk denotes those from which Donations have been received this Session*)

Alnwick . . .	*Berwickshire Naturalists' Field Club.
Bath	*Natural History Society.
Belfast	*Naturalists' Field Club.
Belfast . . .	*Natural History Society.
Bristol	*Naturalists' Society.
Birkenhead . . .	Free Public Library.
Birkenhead . . .	*Literary and Scientific Society.
Bordeaux . . .	*Société des Sciences, etc.
Bombay . . .	*Asiatic Society.
Boston	*American Academy of Arts and Sciences.
Boston	*Natural History Society.
Boston	*The Massachusetts Boards of Agriculture, Education, and State Charities.
Brussels . . .	*Académie Royale des Sciences, etc., de Belgique.
Chester	*Natural History Society.
Chester	Architectural and Archæological Society.
Cambridge . . .	Philosophical Society.
Cambridge (*Mass.*)	*Harvard University.
Cambridge (*Mass.*)	*The Museum of Comparative Zoology.
Calcutta . . .	*Royal Asiatic Society of Bengal.
Calcutta . . .	*The Geological Survey of India.
Cherbourg . . .	*Société Imperiale des Sciences, etc.
Christiania . . .	*The University.
Copenhagen . .	*Academie Royale.

Dublin	*Royal Irish Academy.
Dublin	*Royal Geological Society of Ireland.
Dublin	Royal Society.
Edinburgh . . .	*Scottish Society of Arts.
Edinburgh . . .	*Botanical Society.
Edinburgh . . .	*Meteorological Society of Scotland.
Edinburgh . . .	Royal Physical Society.
Edinburgh . . .	*Royal Society.
Edinburgh . . .	The Philosophical Institution.
Edinburgh . . .	*Geological Society.
Falmouth . . .	*Royal Cornwall Polytechnic Society.
Glasgow . . .	*Philosophical Society.
Glasgow . . .	*Geological Society.
Greenwich . . .	*The Royal Observatory.
Hull	Literary and Philosophical Society.
Halifax . . .	Literary and Philosophical Society.
Königsberg . . .	Königlichen Physikalisch Gesallschaft.
London	*Society of Arts.
London	*Royal Asiatic Society.
London	*Society of Antiquaries.
London	*Anthropological Institute.
London	*Royal Astronomical Society.
London	British Association.
London	British Museum.
London	*Chemical Society.
London	Clinical Society.
London	*Royal Geographical Society.
London	*Geological Society.
London	*Geologists' Association.
London	*Linnæan Society.
London	*Meteorological Society.
London	*Royal Society of Literature.
London	*Royal Society.
London	*Royal Institution.
London	*Statistical Society.
London	*Medico-Chirurgical Society.

London	*Royal Institute of British Architects.
London	Royal Microscopical Society.
London	*East Indian Association.
London	*Zoological Society.
London	*Editor of "Nature."
London	*Editor of "Quarterly Journal of Science."
London	*Editor of "Science Gossip."
London	Editor of "Geological Magazine."
London . . .	*Institution of Civil Engineers.
Leeds	*Philosophical and Literary Society.
Leeds	*Geological Society of West Riding of Yorkshire.
Liverpool . . .	*Architectural Society.
Liverpool . . .	*Historic Society.
Liverpool . . .	*Geological Society.
Liverpool . . .	*Philomathic Society.
Liverpool . . .	*Polytechnic Society.
Liverpool . . .	*Naturalists' Field Club.
Liverpool . . .	Chemists' Association.
Liverpool . . .	*Numismatic Society.
Liverpool . . .	Royal Institution.
Liverpool . . .	*Free Public Library.
Liverpool . . .	Medical Institution.
Liverpool . . .	Lyceum Library and News Room.
Liverpool . . .	Athenæum Library and News Room.
Leicester . . .	*Literary and Philosophical Society.
Manchester . . .	*Literary and Philosophical Society.
Manchester . . .	Free Public Library.
Manchester . . .	Chetham Library.
Manchester . . .	*Owen's College.
Melbourne . . .	*Royal Society of Victoria.
Milan	*Reale Instituto Lombardo.
Newcastle-on-Tyne	*Natural History Society.
New York . . .	*Astor Library.
New York . . .	*American Geographical Society.
New York . . .	*Lyceum of Natural History.

New York . . . State University.
New York . . . *State Library.
New York . . . *State Cabinet of Natural History.
New Haven . . Connecticut Academy.
Oxford . . . . Ashmolean Society.
Plymouth . . . *Plymouth Institute.
Penzance . . . *Royal Geological Society of Cornwall.
Philadelphia . . *American Philosophical Society.
Philadelphia . . *Academy of Natural Sciences.
Philadelphia . . *Franklin Institute.
Philadelphia . . *Zoological Society.
Philadelphia . . *Pennsylvania Board of Education.
Presburg . . . Vriens für Natur-Kunde.
Salem (Mass.) . . *Essex Institute.
Salem (Mass.) . . *American Association for the Advancement of Science.
Stockholm . . . Academy of Sciences.
Southport . . . Literary and Philosophical Society.
Truro . . . . *Royal Institution of Cornwall.
Taunton . . . *Somerset Archæological Society.
Toronto . . . . *Canadian Institute.
Vienna . . . . *Geographischen Gesellschaft.
Whitby . . . . Literary and Philosophical Society.
Washington . . *Naval Observatory.
Washington . . *The Commissioner of Patents.
Washington . . *The Commissioner of Agriculture.
Washington . . *Smithsonian Institution.
Washington . . *The Secretary of War.
Washington . . *The Geological Survey.
York . . . . Philosophical Society.

TREASURER'S ACCOUNT, 1873-4.

Dr. *The* Literary and Philosophical Society, *in Account with* R. C. Johnson, *Treasurer.* Cr.

1873-4.				£	s.	d.
To Cash paid Mr. Marples, for Printing				135	14	7
" " Messrs. C. Tinling & Co., for ditto				11	15	6
" " Mr. Walmsley, for ditto				5	4	9
" " Mrs. Johnson, for Teas				24	4	8
" " S. Burke, for Attendance				2	2	6
To Dr. Carpenter's Lecture:—						
Expenses	44	2	6			
By Tickets sold	9	12	6			
				34	10	0
" " Secretary's Expenses				19	11	8
" " " Editorial Fee				10	10	0
To Balance in hand, viz., Dock Bond				250	0	0
				£498	13	8

1873-4.				£	s.	d.
* By Balance brought forward, viz.:—						
Dock Bond	£250	0	0			
Cash in hand	8	15	6			
				258	15	6
By Annual Subscriptions, viz.—						
148 at 21s.	155	8	0			
8 at 10s. 6d.	4	4	0			
Entrance Fees—22 at 10s. 6d.	11	11	0			
Arrears— 16 at 21s.	16	16	0			
				187	19	0
By Cash, Interest on Dock Bonds, less Income Tax				10	13	9
By Sir Samuel Baker's Lecture:—						
Tickets sold	93	15	0			
Expenses	55	5	0			
				38	10	0
Balance due to Treasurer				2	15	5
				£498	13	8

Examined and found correct,

ISAAC ROBERTS.

EDWARD DAVIES.

PROCEEDINGS

OF THE

LIVERPOOL LITERARY AND PHILOSOPHICAL SOCIETY.

ANNUAL MEETING.—SIXTY-FOURTH SESSION.

ROYAL INSTITUTION, October 5th, 1874.

ALBERT JULIUS MOTT, PRESIDENT, in the Chair.

Ladies were invited to this Meeting.

The Minutes of the last Meeting of the former Session having been read and confirmed, the Honorary Secretary read the following

REPORT.

On reviewing the Proceedings of the past Session, the Council congratulate the Members upon the Society's position at the end of the sixty-third year of its existence. The great impulse which has been given of late years to both literary and scientific inquiry has evidently extended itself to the business of the Meetings, and the late Session was marked by increased activity and by larger attendances than at any previous period. Papers were read upon all the professed objects of the Society; the miscellaneous contributions, which have always formed an attractive part of the Proceedings, were numerous and valuable; and the volume, which will shortly be placed in the hands of the members, will be found a worthy companion to its predecessors.

Two other gratifying features of the past Session are also deserving of mention. The interest taken in the Proceedings led to the Council inviting ladies to ten out of fourteen Meetings, and the roll of Ordinary Members reached the highest figure it has yet attained, namely, two hundred and twenty-eight. This last may to some extent be attributed to the increased advantages conferred upon membership by the institution of the Roscoe Lectures.

At the commencement of the Session the number of Ordinary Members was 207: 26 gentlemen were elected during the Session, while 10 Members resigned, and 3 died; the present effective strength of the Society is therefore 220. Of the three Members deceased, the memory of the late Robert M'Andrew, F.R.S., demands a special notice. He was for many years a highly respected merchant in Liverpool, and became connected with the Literary and Philosophical Society by its union with the Natural History Society, of which he was a member, in October, 1844. He subsequently held the Offices of President and Vice-President, and in October, 1856, retired from the former, in consequence of his removal from Liverpool. His interest, however, in the Society's proceedings was not abated by the change, and the circulars for each Meeting were, at his special request, regularly forwarded to his residence at Isleworth, in the vicinity of London, where he spent the last years of his life. Mr. M'Andrew began his scientific studies, not very early in life, with the formation of a collection of shells. Subsequently, through his intimacy with Professor Huxley, and especially with Professor Edward Forbes, he was induced to take an active part in the exploration of the marine fauna of the British Seas. He was the possessor of a fine yacht, and spent a portion of every summer in dredging, which he pursued, not only in the Hebrides and on the south coast of England, but also in the Mediterranean and Red Seas.

Notes on the results of his researches in these excursions were frequently communicated to the Society, and will be found in the volumes extending over the Sessions from 1844 to 1856. The whole of his valuable collections were placed at the disposal of the National Museum, and the high value of his contributions to the knowledge of the geographical distribution of marine animals was gratefully acknowledged by the most eminent leaders of the British Association, the meetings of which he regularly attended. He made liberal donations of specimens to the Museum of the Royal Institution, and also to the Free Public Museum of Liverpool. His very extensive collection of shells was bequeathed to the University of Cambridge.

The present number of Honorary Members is 41. In this class three gentlemen have been admitted, namely, Professor Max Müller, Sir Samuel Baker, and Professor Alexander Agassiz. The last of these took the place of his father, Professor Louis Agassiz, whose name had been on the roll for twelve years, and to whose family a letter of condolence was sent in December last.

The names of three gentlemen who have entitled themselves to the distinction by their services in the promotion of scientific knowledge, and by their donations to the Free Public Museum, have been placed on the list of Corresponding Members, who now number eleven. No change has been made in the list of Associates.

The Council, in conclusion, recommend the following Members for election on the new Council:—the Rev. E. M. Geldart, and Messrs. E. R. Russell, Morton, H. S. Samuel, and W. Henry Weightman.

The Honorary Treasurer next read the annual balance sheet, which was approved of, and passed, on the motion of Dr. Nevins, seconded by Mr. Morgan.

The election of Officers and the Ordinary Members

of Council followed, when the following gentlemen were elected: Vice-Presidents — Alfred Higginson, M. R. C. S., Thomas J. Moore, Cor. Mem. Z.S., Rev. W. Kennedy-Moore, M.A.; Honorary Treasurer—Richard C. Johnson; Honorary Secretary — James Birchall; Honorary Librarian — Alfred Morgan; Members of Council — Edward Davies, F. C. S., Alfred E. Fletcher, F. C. S., Ewing Whittle, M.D., J. Campbell Brown, D.Sc., &c., Isaac Roberts, F.G.S., Rev. Jacob Prag, T. Higgin, C. H. Stearn, W. Carter, M.B., Rev. E. M. Geldart, M.A., Edward R. Russell, George H. Morton, F.G.S., Harry S. Samuel, William Henry Weightman.

The Honorary Secretary then read over the names of the Associates, all of whom were re-elected.

Mr. Edwyn C. Reed, of the Museo Nacional, Santiago de Chili, was duly elected a Corresponding Member, on the recommendation of the Council.

The President then read his Third Inaugural Address,* after which a vote of thanks was accorded to him, on the motion of the Rev. H. H. Higgins, seconded by Dr. Nevins, and supported by Mr. Picton.

FIRST ORDINARY MEETING.

Royal Institution, October 19th, 1874.

ALFRED HIGGINSON, M.R.C.S., Vice-President, in the Chair.

Ladies were present at this Meeting.

Dr. Millen Coughtrey, Dunedin, Otago, New Zealand, was elected a Corresponding Member, on the recommendation of the Council. Messrs. Francis Imlach, M.D., J. Newby

* See page 1.

Hetherington, and John S. Grant were elected Ordinary Members.

Mr. B. L. BENAS exhibited specimens of rough gold beads, brought from Coomassie, and used by the Ashantees as ornaments.

Mr. ALFRED HIGGINSON exhibited specimens of *Cladonia coccinea*, from Perthshire. The Rev. H. H. Higgins exhibited *Dædalia Quercinus*, recently gathered in Knowsley Park.

Mr. J. A. PICTON, F.S.A., read a brief notice of "The Old Philosophical and Literary Society of Liverpool." *

The Rev. W. KENNEDY-MOORE, M.A., then read a Paper on "Oriental Pantheism and Dualism," an extract from which will be found at page 165.

SECOND ORDINARY MEETING.

ROYAL INSTITUTION, November 2nd, 1874.

ALBERT JULIUS MOTT, PRESIDENT, in the Chair.

Messrs. John Linton Palmer, Staff Surgeon, Royal Navy, Henry Young, and James O. de Wolf, and the Revs. Morris Joseph and A. Scott Matheson, were elected Ordinary Members.

Mr. J. A. PICTON exhibited an extensive series of sketches which he had made in Italy and the south of France, and made some observations on each of them.

Mr. RICHMOND LEIGH then read a Paper on "The Yang-tse-Kiang River." †

* See page 341. † See page 217.

THIRD ORDINARY MEETING.

Royal Institution, November 16th, 1874.

ALBERT JULIUS MOTT, President, in the Chair.

The President opened the proceedings with a notice of the death of Mr. W. J. Lamport, who had been a Member of the Society for twenty-six years. Mr. Picton, the Rev. H. H. Higgins, and others, also spoke in high terms of the deceased gentleman; and this record of the Society's regard for his memory was ordered to be inserted in the Volume of Proceedings.

Messrs. Lewtas, Guthrie, Pim, Parratt, Stöddart, Grindley, and Fothergill were elected Ordinary Members.

Dr. Millen Coughtrey, Professor of Anatomy and Physiology in the University of Otago, New Zealand, Corresponding Member of the Society, made some observations on a remarkably fine specimen of the leg and toe bones of the *Dinornis elephantopus*, part of a very perfect skeleton of one of these extinct gigantic birds, lately forwarded to the Free Public Museum of Liverpool, by Capt. Hutton, Director of the Otago Museum, Dunedin; also on a small series of new *Sertularian Zoophytes*, collected by himself at Otago.

Mr. Picton exhibited a copy of an early edition of Milton's *Paradise Lost;* and Mr. H. S. Samuel, referring to the navigability of the Yang-tse-Keang, discussed at the last meeting, exhibited some photographs of steam vessels which were being specially constructed to ascend the rapids of the Amazon.

The Rev. H. H. Higgins then read a Paper on "Potency in Matter."*

* See page 87.

FOURTH ORDINARY MEETING.

Royal Institution, November 30th, 1874.

ALBERT JULIUS MOTT, President, in the Chair.

Ladies were invited to this meeting.

Messrs. Henry Samuel, Bligh, M.D., and Harvey, M.B., and the Rev. Arthur P. Holme were elected Ordinary Members.

Mr. Jno. Newton exhibited a copy of the first edition of Milton's *Paradise Lost*, which he believed had once been the property of the late William Roscoe. He also exhibited copies of other works, including one of Bunyan's *Defence of Justification*, illustrative of the period when printing presses were subject to royal licence.

Mr. Wood read a newspaper paragraph describing the sanitary properties of the *Eucalyptus*, or Blue Gum Tree of Australia, and suggested its introduction into the churchyards and cemeteries of Liverpool. A lengthened conversation resulted, in which Messrs. Fletcher, Picton, Samuel, Carter, Boult, and others took part, and in which it was shown that attempts had been made to plant these trees in the neighbourhood, and that they had failed in consequence of the rigour of our northern climate.

Mr. J. A. Picton, F.S.A., then read a Paper on "The Origin and History of Notation and the Numerals."*

FIFTH ORDINARY MEETING.

Royal Institution, December 14th, 1874.

ALBERT JULIUS MOTT, President, in the Chair.

Messrs. Murphy, F.C.S., Greaves, and Mellor, and the

* See page 69.

Revs. W. E. B. Gunn, M.A., and R. Black, M.A., were elected Ordinary Members.

Mr. Pim exhibited a large photograph of the *Eucalyptus*.

Mr. Stearn exhibited and explained at length an apparatus for simultaneously filling and emptying the cells of a nitric acid battery.

Mr. T. J. Moore exhibited some large specimens of the *Teredo navalis*, or Ship-Worm, with examples of their borings, from the piles of San Francisco Harbour, presented to the Free Museum by Capt. J. H. Mortimer, Associate.

Mr. J. O. de Wolf also exhibited similar examples from a four-year-old Nova-Scotian ship, the voyages of which had been confined to the Atlantic trade, except one to the Mediterranean. A lengthened conversation followed, which chiefly turned upon the possibility of impregnating wood with liquid poisons, so as to prevent the ravages of the *Teredos*.

Mr. Joseph Boult then read a paper on "Some of the Ancient Jurisdictions in South Britain."*

SIXTH ORDINARY MEETING.

Royal Institution, January 11th, 1875.

ALBERT JULIUS MOTT, President, in the Chair.

Messrs. Bell, Richardson, and Williams were elected Ordinary Members.

Mr. George H. Morton, F.G.S., exhibited piece of a rock section, cut by a diamond boring machine, from the neighbourhood of Huyton.

Mr. R. C. Johnson described at length the results, as at

* See page 299.

present known, of the Observations on the Transit of Venus, and illustrated his remarks with drawings on the blackboard.

The Rev. THOMAS P. KIRKMAN, M.A., F.R.S., then read the third part of his Paper on "Philosophy without Assumptions."*

SEVENTH ORDINARY MEETING.

ROYAL INSTITUTION, January 25th, 1875.

ALBERT JULIUS MOTT, PRESIDENT, in the Chair.

Ladies were present at this meeting.

The Rev. THOMAS P. KIRKMAN, M.A., F.R.S., submitted a communication on the "Janal Dodecahedra." †

Mr. T. J. MOORE exhibited a remarkably fine head and tusks of a Walrus, from Alaska, which had been presented to the Free Museum by Capt. Mortimer, Associate; also a beautifully mounted example of a small portion of *Chain Salpæ*, collected and presented by the same gentleman. Capt. MORTIMER, who was present, made some brief observations on the specimens, and Mr. J. L. PALMER, Staff Surgeon, R.N., also gave a short account of his experiences with the Walrus in Behring's Straits.

Mr. THOMAS HIGGIN then read a paper on "Sponges, their Anatomy, Physiology, and Classification." ‡

EIGHTH ORDINARY MEETING.

ROYAL INSTITUTION, February 8th, 1875.

ALBERT JULIUS MOTT, PRESIDENT, in the Chair.

Dr. NEVINS called attention to a reported falling off in

* See page 117. † See page 251. ‡ See page 193.

the railway traffic in India for the year 1878, and to one of the causes assigned for this decrease, namely—an alleged diminution in the number of marriages, on account of the year being regarded as unlucky.

The Rev. E. M. Geldart, M.A., exhibited two diagrams representing a variety of male *Polyommatus Alexis* (the common Blue Butterfly), along with a typically marked specimen. The variation was on the underside only, and consisted in a remarkable elongation of the black *ocelli*, from which the genus takes its name (πολὺ, many, and ὄμμα, an eye), these eye-like markings being for the most part replaced by streaks, especially along the *costa* of the hind wing, where three spots appeared to be confluent. If we regard the scales of the lepidopterous insects in the light of a sediment, precipitate, or crystallization, from the fluid humours of the *pupa* in which they are held in solution, we can perhaps understand how any constitutional defect involving an excess of fluidity might cause the pattern to run. If we inquire why the spots have, in becoming streaks, taken precisely the direction that they have, we shall find the explanation in the fact that every *ocellus* is traversed by a vein, which by capillary attraction has determined the direction of the blotch. The variety is believed to be unique, and, as such, must for the present be regarded as a pure *lusus naturæ*, though, as like causes produce like effects, we can hardly doubt but that many similar examples have escaped the notice of naturalists. The specimen in question was exhibited in a box. The head and body were mutilated, but the wings intact. It was captured by the exhibitor in August, 1864, on the slope of Box Hill, Surrey, that rises behind the Burford Bridge Hotel; the spot known to lepidopterists as a locality for *Pempelia Carnella.*

The Rev. W. A. Whitworth, M.A., then read a Paper on "Pythagorean Triangles."*

* See page 257.

NINTH ORDINARY MEETING.

ROYAL INSTITUTION, February 22nd, 1875.

ALBERT JULIUS MOTT, PRESIDENT, in the Chair.

Messrs. Thomas Chapman, Thomas A. Bellew, and J. H. Silvan-Evans, B.A., were elected Ordinary Members.

Mr. BAILEY, M.R.C.S., exhibited a large horn of the Rhinoceros, brought from Congo, thirty-five inches in length.

Mr. T. J. MOORE exhibited a collection of rare and remarkable Sponges from the Philippine Islands, kindly lent for the occasion by Mr. S. Trice Martin, of Altrincham. They had been submitted to an examination by Mr. THOMAS HIGGIN, who made the following observations upon them:—

The whole four Sponges belong to the group *Hexactinellidæ*, and two of them are probably new to science. 1. The smallest is an example of *Rossella Philippensis*, lately described by Mr. H. J. Carter, in the *Annals and Magazine of Natural History*, series 4, vol. 10, p. 137. Its spicule complement brings it into the same genus with the Sponge figured by Professor Wyville Thomson, in *Depths of the Sea*, p. 419, and named *Rossella velata*. 2. The bird's nest-shaped Sponge is no doubt a near ally of this genus: it has seemingly not hitherto been named, and, if not, it will shortly be figured and described in the *Annals*. In general appearance it much resembles *Pheronema Grayi*, found off the coast of Portugal by Mr. W. Saville Kent. 3. The bent club-shaped Sponge is an example of *Meyerina clavæformis*, remarkable for the number of crustaceans enclosed in its net-work. How have these creatures become walled up in the skeleton of the Sponge? Have they settled on the Sponge and then remained, because the waterstream brought them sustenance without exertion, or have they fed on the soft parts of the Sponge? It would seem that they have not fed

on the Sponge, because the skeleton is worked round them, and each one is left in a sort of nest of its own. 4. The other Sponge, with a glass rope appendage, is an undescribed Sponge, but is nearly related to *Hyalonema Sieboldi* (Gray). It is interesting on many accounts, not the least of which is the fact that the glass rope is entirely free from the polype usual on the *Japanese Hyalonemas*, and the question as to whether the rope belongs to the Sponge or to the polype is thus finally settled. The surface of the Sponge is a lattice-work, somewhat like that of *Meyerina clavæformis*, but it is all pore-area, the vent being a large, irregular, funnel-shaped opening at the top of the Sponge mass, communicating with cavities about the fixed end of the cord, into which the current is received from the canal system.

Note.—See paper in *Annals and Magazine of Natural History* for June, 1875, "On two Hexactinellid Sponges, from the Philippine Islands, in the Liverpool Free Museum. By Thomas Higgin, of Huyton. With Remarks by H. J. Carter, F.R.S., &c.," pp. 377–390, plates xxi. and xxii., in which No. 4 of the above Sponges is named, described, and figured, under the name of *Hyalonema Cebuense*, by Mr. Higgin, and No. 2, which proved to be the *Labaria hemisphærica* of Dr. Gray, is also fully described and figured by him; remarks by Mr. Carter being appended to each.

Mr. John Linton Palmer, Staff Surgeon, R.N., F.R.C.S., F.R.G.S., &c., then read a Paper on "Davis, or Easter Island," with maps and other illustrations.*

TENTH ORDINARY MEETING.

Royal Institution, March 8th, 1875.

ALBERT JULIUS MOTT, President, in the Chair.

Mr. J. L. Palmer, F.R.C.S., &c., exhibited some articles made from the horn of the Rhinoceros by Chinese workmen.

* See page 275.

He also mentioned several recorded instances of the effects of Sea Drift, with reference to the question raised at a former Meeting on the way in which the Polynesian Islands had been populated. These instances are given in his paper on "Easter Island," which see at page 275.

The Rev. ALDEN DAVIES then read a Paper on "The Arthurian Period of British History."

ELEVENTH ORDINARY MEETING.

ROYAL INSTITUTION, March 22nd, 1875.

ALBERT JULIUS MOTT, PRESIDENT, in the Chair.

The President read a brief communication from the Rev. H. H. Higgins, M.A., who was unable to attend, on some points in Dr. Bastian's recent Lecture in Liverpool, on "Some Transformations of Living Matter."

Mr. W. CARTER, M.B., then read a Paper on "The Effects of Pressure on the Germination of Plants."

TWELFTH ORDINARY MEETING.

ROYAL INSTITUTION, April 5th, 1875.

ALBERT JULIUS MOTT, PRESIDENT, in the Chair.

Mr. R. C. JOHNSON exhibited a series of Synoptical Charts from the Royal Meteorological Society, and published by Capt. Hoffmeyer, Director of the Danish Meteorological Observatory. The series embraces the area of Europe and the North Atlantic.

The Rev. H. H. HIGGINS, M.A., in the course of his remarks on this subject, showed the desirability of an Obser-

vatory being established on the Lancashire side of the Mersey, in connection with that at Bidston. The variations, he remarked, in the atmosphere are greater between two adjacent places than is generally supposed, and some important advantages might be derived from the observations made under such conditions.

Mr. T. J. Moore read extracts from letters, as follows:—

From Mr. Edwyn C. Reed, Museo Nacional, Santiago de Chili, Corresponding Member, dated December 2nd, 1874, on the habitat of the Vicuna.

"This animal, which is not mentioned in Gay's *Fauna Chilense*, is only found in the arid region, on the borders of the desert of Atacama. I have never visited this region on account of the great expense attending travels there, and the paucity of objects, as the Vicuna, Parrina (*Phœnicopterus andinus*), and a little-known Humming Bird or two, are the only things of interest to be found. This morning, by a lucky accident, I have heard that a Vicuna, in transit from Valparaiso to Santiago by rail, has died, and I have taken steps to get it for you. For my part, I wonder that the animal has not become extinct, as the climate of its habitat has changed so much in the last 300 years. The Andes thereabout appear to have risen considerably during the last few centuries, and, of course, every foot of extra height decreases the moisture of the winds from the east. Then again, the Chilians have burnt every tree and bush in the mines, and so altered the scanty rainfall to nearly nothing. Plenty of river beds occur in this region, but they are all, or nearly all, quite dry.

"When Pedro de Valdivia marched from Peru to Chile, in 1540, he found this region well populated, and had to fight hard in order to pass to the south. Now no people could grow enough to eat, from want of water."

From Mr. Samuel Booker, Georgetown, Demerara, Corresponding Member, dated June 25th and Dec. 25th, 1874, giving particulars of the habits, food, &c., of the Manatee, (*Manatus Australis*,) of which he had forwarded an adult and a young specimen to the Free Museum:—

"Georgetown, Demerara, June 25th, 1874.

"The Manatees (*Manatus Australis*) are to be found in almost all the rivers and creeks of this Colony, in fresh water, where they feed on branches and leaves that overhang the water, and a coarse grass. Their favourite food, however, is the young shoots of the 'courida' tree, which abounds chiefly along the coast lands bordering on the sea. These trees shed a quantity of seed, which spring up and germinate very quickly in the soft mud in which they are dropped; and in the wet seasons, when the volume of fresh water discharged into the sea from the rivers makes the water along the coast also fresh, these animals stray away to look for the young courida plants. They paddle themselves into shoal water among them, and are frequently seen grazing, rearing their heads above water, and *twisting the overlapping upper lip round the leaves, much after the manner of the Giraffe.*

"Some of them are killed with a kind of harpoon, but most of them are captured by fishermen, who know their haunts, and when they are feeding surround them with a large Pui seine; they then keep watch until the tide leaves the Manatee, and always endeavour to keep his head towards the land. He is then provoked by touching his tail, when he rushes furiously higher up than ever on the shore, and is then securely fastened with a rope. The Manatees are said to be soothed and kept quiet by rubbing their heads, but as I never tried the experiment, I give it you for what it is worth. The specimen that was butchered to supply your wants was captured as above off the Abury Creek, in this county, and

brought down the coast by the fisherman to Victoria Village, where it was placed in a large dyke, and remained there until I purchased it. Fortunately, adjoining this village was a fine sugar property, 'The Hope,' which is managed by the resident proprietor, Mr. B. H. Jones, who is, like myself, a little 'touched' on natural history. He at once fell into my plans of having our friend slaughtered, and had him conveyed to the estate in a cart. He was then laid in a megass logie (a large building open at the sides, used for keeping the megass, which is the refuse from the canes used in boiling sugar), some twenty-five men were engaged in handling him, and he stoutly resented the liberties that were taken with him; but matters were brought to a crisis by my 'man Friday' opening his nostrils with his finger and thumb, and injecting the contents of a small bottle of chloroform. This was more than manateen nature could stand, and with one plunge and stroke of his tail he knocked over his tormentors like ninepins, but, eventually becoming stupified, he was despatched with a knife and bled to death. I cannot say that I am without my qualms of conscience at being a party to this cold-blooded murder, but if the British public must be allowed to gaze on the marvels of creation, they must take the blame.

"The specimen I sent you is said to be a male about half-grown, or perhaps a little more. They have been captured sixteen feet long. The female is always larger than the male. Only one young one is brought forth at a time, about four feet long, of a dirty white. The mother has a breast extending across the body from one arm to the other; *there are two teats*, placed one under each arm, and the young is carried along under the arm while very small. If the young is attacked, the parent becomes savage, and will attempt to swamp a boat. The tail is used to propel, by bending that end of the body inwards towards the head, like the Porpoise does."

"Christmas Day, 1874.

"I have now the pleasure to inform you, that I have secured another specimen for the Museum, in the shape of a young female Manatee, said to be about two months and a half old, and about four feet and a half long.

"The mother was captured and cut up nearly opposite this town, in the Demerara river, and the calf was brought to me alive, but with a cutlass wound an inch and a half long in the side, and a portion of the cuticle abraded. The latter seems almost impossible altogether to avoid, from the struggles of the animal when captured. This youngster I placed in a slipper-bath, which just suited her; she ate a little of the leaves of their favourite tree, but was, I believe, suckling when taken, and there was no chance of her reaching home alive; so, notwithstanding my qualms of conscience, I felt compelled, in the interests of science, to have her slaughtered."

From Staff Surgeon-Major Samuel Archer, Belize, Honduras, Corresponding Member, giving particulars of the anatomy of a half-grown specimen of the same species of Manatee, lately forwarded by him to the Museum:—

"Belize, July 13th, 1874.

"Just before posting my letter last mail, the Captain of a coasting bungay (flat-bottomed country coaster) came up with a note from Mr. J. Roe, Control Officer at Corosal, giving me the welcome news that he had sent me down a live Manatee which had been captured at the mouth of the Rio Hondo (deep river), our boundary between this colony and Yucatan.

"I went down at once to the wharf, and found the beast lying on the deck. It was a young female, about 6 feet in length, and weighing about 200 lbs. I got a fatigue party, and, fastening a long tether round the base of the tail, hauled

her to the end of a wooden platform leading to the bathing Kraal, and tumbled her into the shallow water, making the line fast to the post. She splashed about in fine style when she found herself in her native element, but soon became quiet on discovering she could not get away. I kept her there for two days, and was very much afraid she would be carried off by sharks before my arrangements were completed, but luckily she escaped them. Whilst I had her she was very quiet if not disturbed, and never showed more than her snout, with *expanded* nostrils, above the water. When she rose she reminded me greatly of engravings I have seen of Hippopotamus swimming in African rivers. She appeared to swim with a rolling motion like a Porpoise, and the flippers are never extended beyond the body, but their motion is from the head towards the tail, the point of the flippers turned towards the median line. When at rest they are folded across the breast. The eye is remarkably small, indeed not noticeable unless searched for. The lips are full and rounded, the upper projecting somewhat. There are a few hairs all over the back, and a good many stiff bristles about the mouth. In the morning I had her hauled up on the beach, and then she lay quietly on her back until the arrival of the butcher. She gave a few deep very human sighs, and two or three times uttered low moans not unlike a cow. The executioner stuck his knife in the chest, and she expired with hardly a struggle. When we came to cut her up we found her in very good condition, thick layers of fat lying between the muscles and beneath the skin, which was of considerable thickness.

"I have forgotten to mention that the lungs extend nearly the whole length of the carcase, the abdominal viscera lying in front of them. The sternum is very short. We had some of the meat roasted for dinner. It looked like pork or veal, but was insipid. The liver you could not have distinguished from calf's liver."

From Mr. Coote M. Chambers, Victoria, British Columbia, January 11th, 1875, Corresponding Member, stating that he was engaged in collecting information for the Society regarding the numerous Indian tribes of that region: –

"I have been for some time past collecting information regarding the tribes of Indians (of which there are a great number), their numbers in each tribe, habits, &c., which, when completed, will forward to you. It is not very easy to gain the information I desire, as some of the Traders make but rare trips to Victoria, and they are the only reliable parties."

And from Mr. R. B. N. Walker, F.R.G.S., Gaboon, West Africa, December 4th, 1874, Corresponding Member, announcing the collection of four very good African vocabularies, and a great number of fragmentary ones.

Mr. Leycester H. Greaves, Member of the Institute of Actuaries, then read a Paper on the question, "What is an Actuary?"

THIRTEENTH ORDINARY MEETING.

Royal Institution, April 19th, 1875.

ALBERT JULIUS MOTT, President, in the Chair.

Ladies were invited to this meeting.

Before the commencement of the usual business, the members assembled in the small library for the purpose of electing a President for the ensuing term of three years. After a few introductory remarks by the retiring President, the Rev. H. H. Higgins proposed that Mr. J. A. Picton, F.S.A., should be elected to the chair. This was seconded by Mr. Baruchson, supported by Dr. Nevins, and carried with acclamation. This election was then reported to the general

meeting by the President, and Mr. Picton being present, briefly acknowledged the compliment.

Mr. Robert Gordon, Government Engineer, British Burmah, was elected a Corresponding Member, on the recommendation of the Council.

The PRESIDENT then read the following brief address:—

"When we meet again my only duty will be to resign this chair to my successor; and I cannot close a three years' term of office without an affectionate recognition of the kindness which, having first conferred your highest honours upon me, has made their possession an unmixed pleasure to myself.

"In my own relation to this Society, this is the year of my silver wedding, for I joined it in 1850; and time so inexorably thins the ranks of all human associations, that I am now one of its oldest members. I speak, therefore, with the authority of long experience, when I bear testimony to the permanent value of this Society; to the admirable spirit which pervades it; to the freedom, and at the same time the friendship of its discussions; to the union of open and manly speech, with patient and courteous hearing; to the general excellence of its papers; and to the very large amount of important information which its members communicate to each other. Even higher than all this I set the friendships that are formed here, and through them, the constant encouragement of studious work, of intellectual tastes, and of permanent interest in subjects pure and ennobling in their influence, and in their nature inexhaustible. All that I am saying I myself have felt most strongly during the last twenty-five years, and I say it for the sake of the younger men in Liverpool, who lose immeasurably when they miss the opportunity of early association with Societies like our own.

"I have had the happiness of presiding during one of

the Society's most prosperous periods, in which the number of our members has risen to its highest point, but if we compare this with the vast population round us, it still seems extraordinary that the declared votaries of Literature and Philosophy should not be far more numerous here. Our work does not depend on numerical strength, nor ought we at any time to estimate our own position by this alone; but in the interest of others we must always desire to see our ranks increase. I have lived to see one remarkable and most happy change in the nature of our own discussions. The impatience of opinions which bear upon theological debate has died out to an extraordinary degree, and now, with a little courteous consideration for each others feelings and prejudices, we are able to discuss subjects that could not even be alluded to here some twenty years ago. This is a release from bondage in which I think we all rejoice. We have only to use our freedom soberly and wisely to insure its permanence. But human infirmity remains the same in essence, though it varies in expression, and the present danger is that dogmatic science may take the place of dogmatic theology, and that theories concerning Matter, Force, and Law, may represent a spirit of intolerance as fatal as that of former creeds. It will be our duty, and, I have no doubt, it will be our general endeavour, to discourage this tendency wherever it appears; to maintain an earnest, manly, and vigorous inquiry after truth in all directions, but to combine with it the modesty which becomes all finite beings looking out into the infinite; the forbearance which we owe to the thoughts of other men, who are all in most things even as ourselves; and the reverence of heart which no heights of speculation can disturb, unless we forget that we live and move, by no power of our own, in a universe of inexpressible grandeur, among blessings as unnumbered as the sands.

"I will only add the expression of my most sincere and cordial thanks for the hearty and generous support which I have received from the Society at large, from the Members of Council, and from all my brother officers, with the hope that we may long continue to work together, and that the experience of my successor in the Presidental Chair may be as happy as my own."

Mr. Moore exhibited some specimens of Sponges collected by Capt. J. A. Perry, Associate of the Society, and presented by him to the Free Public Museum. Mr. T. Higgin having examined these Sponges, made the following remarks thereon:

From Port-au-Prince.—A good specimen of *Luffaria fistularis* on a piece of *Millepora*. The same Millepora carries several patches of an *Isodictya*, and four species of *Halichondria*. In the same parcel was a small piece of a *Pachymatisma*, whiter and more delicate in structure than the British species *Johnstonia*, but differing from it only slightly in detail.

From Kingston, Jamaica.—A dark red-brown Sponge of the family *Halichondria*, with a fibrous skeleton—the spicules smooth.

From Progresso, Yucatan.—Specimens of Fibrous Sponges.

From Iquique.—A *Suberea*, and three examples of a *Halichondroid* Sponge.

Mr. J. L. Palmer, Staff Surgeon, R.N., exhibited one of the new Admiralty Polar Charts, and communicated the following particulars with regard to the new Polar expedition. After reverting to the previous expeditions sent out by the British Government, Mr. Palmer observed that the ships now commissioned are H.M.S. *Alert*, and a whaler re-named the *Discovery*. They are of about 700 tons each. They have been "doubled," as the term is in Portsmouth, and we are assured the equipment is as perfect as can be made, and as only this country as yet has done.

The crew of each is sixty officers and men. Small, but it is absolutely requisite to go to the minimum when a ship has to carry provisions, stores, coals, &c., for at least three years. The crew, with the exception of the three ice-masters, in each ship, are picked men-of-wars men. Two naturalists go, and so two officers have had to be removed; and as now a chaplain has been appointed to each, which is unusual in ships of even double the size and less than four times the crew, the two pay-masters have been removed. There are sixty dogs waiting in Greenland; and there are some tons of dog-biscuit made for them. As regards instruments of scientific research, as many have been provided as stowage could be found for. As far as can be judged, the ships will leave at the end of next month, and endeavour to pass up Smith Sound, and northwards. Here, if they can get up to 81° or 82°, one ship will be left, and she will find plenty to do, in the spring and summer of 1876, in exploring North Greenland, or any other work entrusted to her; and she could here await the return of the leader, or get further instructions from him. What Capt. Nares will do will probably be to push north. Should the ships winter apart, they will use their endeavours to communicate, in the spring of 1876, by travelling parties, and sledges with dogs, and one ship will be in a position to receive the crew of her consort should such be necessary. It is also part of the scheme that a ship is to visit Smith Sound in 1877, in case the expedition has not returned. The present expedition goes by way of Smith Sound, which has been chosen principally because ships will be able to go in a straight line of water—according to the Arctic canon, "never turn a corner"—up to 82° north, and besides other advantages on which all Arctic authorities agree. But it is not to be imagined that the success depends on reaching the Pole; the value of this attempt to do so, however, will be in what will be observed

during the march, and the work is to thoroughly explore as large an area as possible of the unknown region which teems with objects of great interest in all branches of science.

For working time.—At the *Polaris*' wintering place in 82°, there are 138 days without the sun, and they are quite in the dark for three months; in latitude 85° there are 153 days of darkness. To counterbalance, whenever the moon is above the horizon, she is full in the winter—in summer she is in her first or second quarter. Temperature has little effect on travelling parties. As soon as it is light enough, say at the end of February, one can work till the end of June; then, from the thaw, sledging has to be discontinued.

Sledge work.—Sledge, with tent and six weeks' provisions, could be dragged twelve miles a day. But it is proposed to put several sledges on the same track, and all but one sent gradually back—each, before it returns, filling up the advanced sledge. If the land proved continuous, depôts of provisions would be sent on in advance. The ground would have to be travelled over as quickly as possible to the northern depôt; there the sledges would be filled up, and the start made for the Pole. Two dogs drag on good ice as much as one man, and do not eat as much. Sir L. McClintock took 106 dogs' provision in his sledges, and his journey may be put into a tangible form, so to say, by imagining any one to start from London by the east coast, go to Edinburgh, and return by the Lake district and Wales. That was what Sir L. McClintock did.

Chance of an open Sea.—There is a regular southward current through Smith Sound and Prince Regent's Inlet, and it is very strong through Hecla and Fury Straits, and Hodson's Straits, and down the Coast of Labrador. It was this current that brought out the abandoned *Resolute*, and about July clears out the ice from Smith's Sound. The hydrographer infers from this, and other circumstances, that

there is no continent or mass of land in the area north of Greenland, and Sir E. Belcher saw no land from north Cornwall, nor did his travelling parties going westward. If continuous, or nearly continuous land is not met with, the distance to be done by sledges and boats combined is very limited; and if there are channels, boats alone can do it up to September, when the young ice begins to force, and then sledges only can pass. It was the *broken ground*, so to say, which frustrated Admiral Wrangel's sledge attempt. Capt. David Gray advocates the east route, as he says he has for thirty years sailed there, and could have gone to very high latitudes without hindrance very often; and inclines to think Smith Sound is a *cul-de-sac*, as the rise of the tide there was eighteen feet in southerly winds, though but five or six at the Duck Islands (Melvill Bay). If the tides, however, meet at Cape Fraser, that might account for it, and prove the connection of Smith Sound with the Polar Basin, and the ascertaining this seems to him one of the most important points connected with the question. But we must remember that nothing is so uncertain as ice navigation; the wind hanging in a certain quarter for a couple of days will upset the best schemes, and if by these means a ship cannot reach within such a distance of the Pole that travelling parties cannot reach it in so many days, then it cannot be done.

Expeditions up Smith Sound.

Inglefield, in yacht *Ysabel* . . .	latitude	78½°	1852.
Dr. Kane, in brig *Advance* . . .	"	81°	1853.
Dr. Hayes	"	81½°	1860.
Capt. Hall, in *Polaris*	"	82° 25′	1872–3.

The Paper for the evening was read by the Rev. E. M. GELDART, M.A., the subject being "Illustrations of Grimm's Law."*

* See page 351.

ON THE MATERIALISM OF MODERN SCIENCE.

By ALBERT J. MOTT, President.

The time is near at hand, if we may judge our age by its tendencies, when the pursuit of science will have to justify itself anew to the reason of mankind. It is not a matter of course that human beings should spend the hours which remain to them, after the necessities of life have been provided for, in exploring the mysteries of Nature or unravelling the threads of history. That great happiness may co-exist with little knowledge is a fact of daily observation. That it increases in this world in the ratio of our intellectual acquirements has never been proved, and is far from probable. We know how often the lives of learned men are melancholy lives. Health injured in the laboratory; eyesight dimmed behind the telescope; strength exhausted in toiling over hills and deserts; time, which never returns, spent in the severities of study or the languor of overwork; all these are the common incidents of scientific research, and must continue to be so while human nature remains the same. And although there are some men in all ages who devote themselves to science by an irresistible impulse, which requires no stimulus, asks for no reason and defies all possible discouragement, this fact, instead of recommending such studies to mankind at large, removes one powerful motive to their general pursuit. For nature will in any case be continually explored by these, her natural devotees; the main truths discoverable at any given period will be discovered by them; the rest will receive whatever practical benefit arises from such discoveries without any effort of

their own, and the utilitarian purposes of science are in this way sure to be attained, at all events to a considerable degree.

The grounds on which the acquisition of knowledge through laborious study, not forced upon us by immediate wants or special instincts, can be seriously advocated, belong altogether to our conception of human life itself, its destiny, its purposes and its proper aims, and these being themselves among the subjects of scientific research, our conclusions concerning them are the most important and fundamental of its products; the elements by which alone we can determine whether its further prosecution can be worth the time and pains it must demand.

Now we are accustomed to take for granted that it is of course worth this time and pains, and the reason is very obvious. We belong to a race which as such has never doubted the immortality of the human soul, and the special form in which this is the belief of Christendom at once determines our views of the nature and ends of life. Mental powers which are to be used, not for fifty years but for ever, are of course worth cultivating for their own sakes here. To fit ourselves for future and endless occupations, not to make an ephemeral life as pleasant as may be while its lasts, is the work suited to our present condition. Nothing in the universe can be uninteresting to us whom the universe itself cannot outlive. No acquisition of knowledge can possibly satisfy our proper wish for it, when the field and the time before us are both of them recognised as infinite. These, which are the mere aphorisms of common sense, are raised into the axioms of philosophy by that conception of higher natures and Power diviner than our own, which is the necessary adjunct of a belief in human immortality in any form; and this belief gives a final reason for unlimited effort

towards our own mental progress, by altogether freeing us from the fear, which would otherwise be overwhelming, that life may slip away for ever while we are only preparing the ground on which no harvest can ripen, and where our labour will have been in vain.

It is this philosophy, deeply planted in all civilised nations of modern times, that causes an intuitive assent to be given to the wisdom of laborious study and of present sacrifice, for the sake of mental growth. It is of course in perfect harmony with Christianity itself, inasmuch as all the reasons that are valid in seeking our own improvement are, from the Christian point of view, still more so if we seek the improvement of others.

But modern science has been coming to some momentous conclusions, which are in their essence destructive of every philosophy of this kind, and if these are true we have no right to take for granted on the existing grounds that the advancement of knowledge must be good for us. The philosophy on which all our habits of thought are founded assumes as its first postulate that two different kinds of being actually exist, and are apprehended by us as existing. We call them matter and mind; body and spirit; the material and the immaterial. We never question the fact that in using these words we are naming two orders of things essentially unlike each other, or that their existence and their difference are intelligible to us. One of the most essential points of difference is in their relation to human life. Human life, so far as it depends on the existence of our bodies, depends on that which is in its nature transitory. The elements of which our bodies are composed appear themselves to be indestructible, but they exhibit none of the phenomena of human life unless combined in this complicated and unstable form. And since different living bodies are successively formed by the combination of the same

particles of matter, no power can reconstruct them so that all should exist again at the same time. A living body is not in fact, but only in appearance, the same being from day to day. If we watch a moving crowd at such a distance that we can see no movement, but only see that the same points are always occupied by similar forms, those forms seem permanent in those positions, and that which changes at every moment may appear unaltered for any length of time. But as in a crowd like this, so in our bodily frames, if each successive particle or union of particles possessed a consciousness of its own, they would have no notion of identity with those which preceded them. Such a notion can only be entertained by a looker-on, and by him only through imperfect observation.

On the other hand, our mental nature constantly asserts its own permanent identity, and while perfectly aware that thoughts, feelings, and all mental operations or states succeed each other, and form a series and a process, it maintains always that these do not constitute a mental being any more than motion constitutes a material particle, and that the being who feels and acts continues the same being, as strictly as the moving particle continues to be the same. All the explanations of what we mean by mental identity either admit this or else they are arguments to prove that successive thoughts and feelings give rise to one permanent thought or feeling, which we call the consciousness of identity; and that the notion thus embodied is untrue. The notion, however, is ineradicable, and forms a necessary part of the philosophy I am considering.

Now the bearing of this part of our philosophy upon the question of human immortality is very clear. To think of a dead body as simply restored to life, and as being then the same living person as before, is easy enough in a certain

stage of ignorance, but becomes quite impossible as soon as we notice what happens to the body after death. This has been everywhere perceived, and the literal identity of bodily forms in a future life does not, I suppose, form part of any theory on the subject. The identity with which we all feel concerned is mental identity. We change our bodies constantly in the present world, and can imagine ourselves inhabiting any sort of external form. But the very forms we now stand in would cease instantly, not only to be ourselves, but in any way to belong to us, if our minds left them and other minds took possession of them.

Now if my mental identity does in fact depend on the existence of my present body, that is, if it depends on the maintenance of this organic form by the constant succession of material particles, replacing each other in one unbroken series, it must follow that when this body goes to pieces in such a way that it cannot be reconstructed, I myself must perish with it altogether and for ever. Another being, exactly like me, might be made, and thoughts and feelings like my own might possibly be given him. But the simple fact would still only be that two individuals precisely similar to each other had lived, and that one of them was dead; not that the dead one was alive again. My existence has no concern in, and no influence upon, the existence of my duplicate. What is really necessary to my continued existence hereafter is that my mental identity should depend on something which does not go to pieces as the body does, or which, if this should happen, does not become the material out of which other beings are made, and which, therefore, it is not impossible to put together again. If the material body constitutes the whole of the living being, this indispensable condition can never be fulfilled, except by the grotesque theory, sometimes adopted, which supposes that the living principle resides in some small, and of course

undiscovered, portion of the body, which in fact is never decomposed.

But if mental existence is a different thing from material existence, that is, if the fundamental postulate of our common philosophy is true, this difficulty never can arise. Whatever the essence of mind may be, we have no ground for thinking that dead minds, like dead bodies, are used up again in the construction of living ones. There is no such reason, therefore, why consciousness may not be restored to the mind which has lost it. The identity of the being is not destroyed by the mere fact that it has ceased to think and feel. The destruction occurs only when the being itself is divided into parts, and these parts become portions of other beings. You may keep a seed for centuries without a sign of animation, yet able to revive and continue the life it had before. But if you once break it up, and let its elements become the elements of other seeds, revival is of course out of the question.

When any doctrine of a future life is presented to us, whether as the inference of reason, or the teaching of authority, or both, the reception we give to it as rational beings must evidently depend on the view we take of this fundamental question. If there is no preliminary objection to the fact asserted, on general grounds, we can weigh the evidence without prejudice, and judge according to its cogency; while if our philosophical views have already placed it among impossible things, we are obliged either to reject all evidence in its favour as necessarily faulty, or else to affirm that there are two kinds of truth while we deny that there are two kinds of being, and to admit that what we see to be impossible may nevertheless take place. The latter view is doubtless held at present by many men of high scientific attainments, but there are no elements of stability in it. When our faith and

our philosophy mutually support each other, there is no reason to fear that either will be overturned; but when they contradict each other, the ultimate destruction of one or both is already certain.

It is this all but universal philosophy which, by asserting two kinds of existence, has made the continued life of the human soul a thing probable in itself, and therefore susceptible of proof by ordinary evidence, and which has thus become the true foundation of our general view of life, its objects, and therefore its motives, and through these its maxims, and the common standards by which we estimate the value of its pursuits; it is this philosophy with all its consequences which is now assailed by the theories of modern physical science, as they are accepted and taught by many of its leaders, and probably by the majority of its younger students. These theories assert that the only existing things known to us are material things, and that if anything of a different nature does in fact exist, we have no faculties by which it can be apprehended. The facts concerning material bodies, their properties and their changes, are therefore the only facts within the reach of human intelligence; the search after anything else is a vain and useless search, and any fancied knowledge on such subjects is fancy only. These views are supported by considering the sources of human knowledge. We become acquainted with things around us only by the action of the physical organs of sense. That action itself is only physical change, and is only brought about by the physical changes of other bodies. All that is thus communicated to us, therefore, is in fact nothing but physical change, and this alone is the substance of all our knowledge.

The full result of these theories is not indeed generally appreciated, is often kept out of sight, and is believed by many to be cancelled by certain explanations, the soundness

of which is vaguely hoped for, but is not vigorously put to the test. But it is clear that, on this materialistic view of things, any belief in human immortality must be founded on the supposition that its inherent difficulties can be got over in some way which is unintelligible to ourselves. But why, then, should we make this supposition? In what manner could we come to know that it is justified? The question is a crucial one, and the inevitable answer is, that the supposition could not be justified.

For if our only sources of knowledge are only able to make us acquainted with the facts of material change, our ignorance of all other facts is necessarily absolute, and no supposition concerning them can have anything to rest upon. Knowledge, like the senses which supply it, is on this theory only a name for material change, and what, then, is meant by knowledge of anything besides? Yet the supposition must be that we do come to know that there is something else, and that this justifies a belief in immortality. That is to say, that, being ourselves purely material, and in relation only with matter and its changes, we yet come to know a fact which material changes not only cannot account for, but cannot so much as render possible in itself. This is the climax of self-contradiction.

Let me recapitulate a little. Our desire for the advancement of knowledge, and our conviction that a great part of life should be devoted to intellectual pursuits, are the result not of a universal and irresistible impulse, but of a reasonable judgment, founded on our general view of human life itself, as expressed by our common maxims concerning it, which are the axioms of thought in this direction. But these themselves are founded on and derived from the assumption that human life is not related to this world only, and that it is not ended with the grave. And this assumption of immortality itself depends on the belief that there are

two kinds of existence, and that the human soul is not the same thing as the human body.

If the fact is otherwise, the doctrine of continued life becomes incredible, or can only be held in defiance of all the inferences of reason. If life is thus shortened to a few brief years, our whole view of it with all its objects must, if we are rational beings, be utterly changed. If it is thus changed, the maxims which serve as guides, and the conduct based upon them, cease to be reasonable since they lose their foundation. The entire theory of life must be re-considered, and, as I began by saying, the pursuit of science will have to justify itself anew to the reason of mankind.

There are philosophers of the purely materialistic school who will not shrink from accepting this challenge, and will undertake to prove that sufficient reason can be given for intellectual and moral culture, even on the supposition that our conscious identity expires with our latest breath. I believe their arguments are futile, and their efforts necessarily vain, but I postpone the discussion of that question. That it is of infinite importance no one will dispute. My object so far has been to show that the question is necessarily raised, if the materialistic doctrine is accepted, and I shall now endeavour to point out to you what I conceive to be the general fallacy of the reasoning which leads to its acceptance by the students of physical science.

On the threshold of the inquiry we are met by the fact that a belief in two kinds of existence, material and immaterial, has been nearly universal everywhere. It is necessary to the materialistic philosophy that this fact should be accounted for, and the task has been undertaken by Mr. Tylor, in those remarkable chapters on Animism which occupy more than four hundred pages in his book on *Primitive Culture.* Very few, I believe, have read these chapters

carefully. It is a work of considerable labour; and even the sense in which Mr. Tylor uses the word Animism is perhaps unknown to many. He means by it the doctrine of spiritual beings generally; the belief, that is, in some kind of existence which is not material. He shows by an enormous accumulation of details that this belief is not a product of recent civilisation, but is universal among all savage tribes. Adopting the savage theory as to the origin of existing races, he assumes that civilised man has inherited this belief from his rude ancestors, and that the grounds on which they acquired it are therefore the grounds on which it really rests. He then considers in what way the lowest races can have acquired it, and he finds an answer to this question in the effect of dreams upon the imagination of savages. Dreams are common to all men. The beings we seem to meet in them appear to us to be really present. But we find their bodily forms have not been really present. Hence an inference that they have a second form which is independent of the body. The excitement of fever leads to similar results. The inference is supported also by imaginary forms which we often think we see in dim light; by the shadows of objects, and by their reflection in water. In all these cases, what appear to us to be material beings are found in fact to have no objective existence. This constant experience, according to Mr. Tylor, has produced in the minds of savages generally a belief in the double nature of all visible things; in a material body which can be touched, and in an immaterial body which cannot be touched.

From this settled conviction, originating in the lowest tribes and handed down to other races, Mr. Tylor supposes the belief in spiritual beings to have been derived. It is, I think, the only attempt that has been made to give a reasonable account of the universality of this belief on purely physical grounds. It is extremely interesting in itself, and

it has at first sight a very plausible appearance, but it will not bear close examination.

You will see at once that the savage origin of mankind must be assumed before the reasoning can have any force whatever. But in fact it has no force even on that assumption. If savages believe in spirits because they cannot otherwise account for dreams and optical illusions, it is certain that cultured races do nothing of the kind. It is soon perceived that shadows and reflections have no separate existence, and that the general phenomena of dreams are like those of fancy and of memory. If in special cases communication with spiritual beings is ever believed to occur in sleep, among ourselves, it is because we already believe that there are such beings who might thus address us; not because the evidence of this is furnished by our dreams. This is not a case of a belief received traditionally and accepted carelessly, without considering the grounds on which it rests. The validity of its evidence has occupied the profoundest thought of the greatest thinkers for an unknown length of time, and the reasons suggested by Mr. Tylor have had no influence upon minds like these. It is in moral and intellectual evidence, not in the evidence of the senses, that the great leaders of cultivated thought in all ages have found the proof of spiritual existence; and there is no reason in the world to think that the effect of this evidence upon the minds of the higher races has anything to do with the conclusions drawn by savages from facts of a totally different kind.

In all departments of thought different men support the same beliefs, both true and false, by different and independent reasonings, and it is remarkable how often that which could never be really anything more than confirmatory evidence in favour of an opinion is mistaken for the actual source of it. What, for example, can be more striking than the difference

among the reasons given for general obedience to human governments. All races, savage or civilised, in which governments exist, are agreed as to the obligation; but some found it on the divine right of kings, some on the natural rights of majorities, some on the precepts of religious teachers, some on vague superstitious fears, some on notions of inherited rank, some on general expediency. The last of these is doubtless the effective reason in all cases. The practical advantage of having a government and of submitting to it is universally felt; and the other reasons are really only reasons for submission to particular forms of it, the necessity for some form or other being taken for granted.

It is precisely so with the belief in spiritual existence. Certain mental facts, of which all men are conscious, produce in most men the belief that soul and body are different things, and the various arguments which in different states of culture are brought forward in support of this, are only the grounds on which particular conceptions of the fact, and not our assurance of the fact itself, are founded.

And since it is certain that civilised races hold their belief in spiritual existence for reasons which are not those suggested by Mr. Tylor as the cause of savage opinion on the subject, it is impossible to prove and unreasonable to imagine that savage opinion has really been formed in this way.

Without discussing here the question of a real savage origin for the human race, I must point out how vast an error is committed when it is supposed, even as a possible truth, that the existing savage races can have remained isolated and unaffected by the ideas of civilised men from what are called primeval times. The tacit assumption that this has been or may be the case is, I think, the most serious fallacy in the whole modern theory on this subject.

For consider the ascertained facts. We know that powerful and civilised nations existed four thousand years ago; that for at least that length of time the great bulk of the world's population has been under the influence of such thought as is expressed in the ancient literature of Egypt, Assyria, Judea, Persia, India, and China; that war, commerce and adventure have been hurrying men to and fro upon the earth during the whole of that long period. What part of the world can we suppose to have remained altogether unvisited by either the armies, the emigrants, the merchants, or the travellers of its civilised states? We mistake the absence of remembered intercourse and present knowledge for evidence of a permanent isolation, which is quite impossible in a world full of living and restless beings. Every nation has next door neighbours who receive some influence from it, and convey this again to those beyond. Every nation has individual stragglers who pass in all directions beyond its boundaries and never return. Even in the ocean, in the course of many centuries, all islands are visited by strangers either through accident or design. Actual proof of these facts, though really needless, is abundant everywhere. Stone implements are frequently found, made of materials that must have come from a distance. Metal work gives evidence of the same kind. Special resemblances in the arts of life; the wide diffusion of languages and races; the frequent legends concerning the advent of strangers; all show us, as might be expected beforehand, that on this earth, where there are only fifty million square miles of dry land, and a thousand million human beings to live upon it, an interchange of thought goes on perpetually and reaches to every part. This is so simple a question of common sense, that it seems only necessary to state it in plain words in order to command assent. Yet it has been entirely overlooked, though it strikes at the root of the whole evolution

theory as applied to the development of human thought. For it is clear that the knowledge and the arts of savage life tell us nothing about an earlier condition of human nature, unless they have been really self-developed, and have not been suggested by intercourse with higher races. But we can never know this to be the fact unless we know that higher races cannot have had any influence over them, and this, instead of being probable in any case, is manifestly impossible in almost all. A single straggler from a higher race into the midst of a lower one is certain to introduce a whole set of new ideas, and forty centuries are more than sufficient to convey this influence to the ends of the earth. Mr. Tylor is so fully aware of the rapidity with which savage ideas are modified by any intercourse with civilised men, that he very properly rejects as doubtful examples of purely savage thought the legends of a later date than the period when such intercourse is known to have been established. But he falls into the common error of supposing an absolute isolation to have existed previously.

The fact that a belief in two kinds of existence is almost universal among mankind, in all shapes of culture, still remains, therefore, to be accounted for. But that there should be any difficulty in accounting for it arises, I think, from a cardinal defect in that doctrine of Experience on which the materialistic philosophy supposes itself to stand.

That doctrine appears to take the following form. Experience includes all our successive states of consciousness, or at least all that can be remembered. Every state of consciousness depends on changes in the condition of our material organism. Those changes are brought about by contact with the material universe, through the organs of sense, external or internal. The changes themselves, therefore, are only such as one material thing can produce in another. Knowledge, being one form of consciousness,

depends on these very changes, and cannot therefore relate to anything that is not material. When we speak of immaterial existence, therefore, we speak of something about which nothing can be known, because there is no avenue of sense by which it can affect us.

The defect of this view, and of the materialistic doctrine generally, is that it confounds the physical conditions of experience with experience itself, which is nothing but mental change; and that it tacitly assumes, in defiance of the evidence, that consciousness depends on nothing but physical change.

Now this could only be proved by showing that consciousness *consists* of nothing else but physical change, and the fallacy discloses itself the moment we use these words. For if our words have any meaning, physical change and consciousness are the names of two different things, not of one and the same thing. It is not possible for us to understand by any physical state or motion what we understand by consciousness. If I see an object, certain molecules vibrate in my brain. If they do not vibrate, I do not see; but the vibration and the seeing are not only not the same thing, they are totally dissimilar, and are quite as incomparable as a colour is with a number, or a clock with the hour of the day.

This is admitted as a fact, but is very imperfectly apprehended. Professor Tyndall, for example, adopts the misleading statement that, when we see, what we are really conscious of is an affection of our own retina.* An affection of the retina is one of the external conditions of sight, but we are no more conscious of it than of the ethereal movements by which it is affected, or of their remotest physical causes. Consciousness knows nothing about a retina, or

* Tyndall, Belfast Address, 1874, p. 29.

any of its changes. Our own bodies are as much external objects to ourselves as any other material things; and this is especially and unreservedly true concerning the brain and the nervous system, the very existence of which is only known to most of us through a series of inferences drawn from other men's observation.

The absolute difference between a conscious state and a physical condition is felt where its consequences are not acknowledged; and we generally find consciousness spoken of, not as physical change itself, but as the product of it.

But, then, what is a product? Unless it is a new creation it is something which in fact existed before, but is now in an altered state. If we say that consciousness is a product of physical change alone, we can only mean that the physical substance which has undergone a change has at the same time become conscious. What, then, is our notion of consciousness as a condition or quality of a physical substance, and by which of our senses do we apprehend it as such? If I say a thing is hard, I appeal to the sense of touch; if red, to the eye; if sweet, to the palate; if noisy, to the ear; if fragrant, to the nose; if heavy, to the muscles or the nerves. These are all avenues of sense by which I believe that external things affect me. From the mode in which I am thus affected, I infer the existence and the qualities of those external things, and I call them material objects. But when I say of anything that it is conscious, what sense am I appealing to? In what way does it affect me by being conscious? Clearly, in no way whatever. I have no avenue of sense by which the fact can be made known to me as the facts concerning material objects are made known. Your bodily forms and movements affect me as I address you, and make your bodily presence known; but how can I know your

thoughts by any such means? or how can I conceive it possible so to know them? All my knowledge of physical facts comes to me through my physical senses, but none of my knowledge of mental facts is attained in that way. I do not know what they are by inference from my sensations; I know it by direct knowledge of myself as a mental being alone.

The mistaken idea, that what can be verified by the physical senses is worth attending to, but that what cannot be thus verified can never be known, requires a few more words of examination.

Absolute unconditional knowledge is only possible concerning our inward selves. We are conscious, and we know the facts of our own present consciousness; and this knowledge is absolute. To be conscious, and to know the facts of consciousness, are not identical states, but they are both states the existence of which we are always able to affirm unconditionally.

Some of the facts of consciousness, which we call the impressions of the senses, make us infer the existence of material things. This inference we also call knowledge, but it is never absolute or unconditional; it is knowledge of another kind. We cannot affirm that a material object exists and affects our consciousness, in the way in which we affirm that we exist and are conscious.

But the absolute knowledge we have of ourselves extends to nothing beyond ourselves, and is therefore of very limited interest to us as living beings. To know our own states of consciousness is not to satisfy our natural desires, which turn continually from the feelings we experience to the inferences we draw, and find their proper exercise and pleasure in doing so. The inferences drawn directly from our sensations constitute the most perfect kind of knowledge we are

able to acquire concerning things external to ourselves. Experience assures us that within certain limits such inferences may be relied upon, that expectations raised by them will be fulfilled, that wishes guided by them will be gratified, that our confidence in their general truth is never shaken, and that the more carefully we examine them the more correct our conception of external facts appears to be. These inferences thus form the largest portion of human knowledge, and especially of scientific knowledge, in which the desire for exact conclusions, which can be verified again and again without difficulty, finds the fullest satisfaction.

Now the reason why an inquiry into anything beyond these direct inferences from what is called the evidence of the senses is discouraged by scientific men in the present day, is supposed to be because no real evidence exists by which such an inquiry can be answered. The truth, however, is that the evidence is the same as that on which modern science itself relies, but that the conclusion has to be arrived at by a double inference instead of a single one. It is, in consequence, far more difficult, and far more liable to mistake, and it requires corresponding diligence, patience, and caution.

In considering the growth of a tree, for example, we have first to infer the physical facts from our own sensations of sight and touch, and then, from this first inference, to draw a second, as to those causes of growth which cannot be inferred directly from our sensations.

But the basis of all other knowledge is the knowledge of ourselves as beings who can think and feel. This is not the knowledge of any physical fact, all that we know of physical facts being inference founded on it.

Now when something is known to us which cannot be intelligibly accounted for by the elements supposed to be present, the natural and the strictly scientific inference

is that some other element is also there. A new line in the spectrum suggests the existence of a new material. The radiation of light and heat through an apparent vacuum determines our belief in an all-pervading ether. The movements of a magnetic needle convince us that the needle is controlled by other sources of energy. The facts of gravitation between bodies at a distance satisfy men of all schools that something besides the gravitating bodies is concerned in them.

Nor is there much disposition to assume that matter itself is only of one kind. The difficulty of supposing all the known elements to consist of precisely similar atoms, differing only in their grouping, is very great. Nor can any reason be given why only one kind of thing should be in existence, or why there should not be mutual relations between different kinds. When, therefore, we see the facts of life associated with certain material arrangements which cannot in themselves account for them, we ought, as sound philosophers, to conclude at once that there is something here besides these material arrangements.

A serious error of conception on one particular point has much to do with the prevailing materialism of scientific thinkers. We are asked whether, when we speak of "living powers," or "ourselves," we can form a mental picture of any one of these apart from the organism through which it is supposed to act.* The question inverts the whole mental process. It is not from a consciousness of the organism that we infer the existence of ourselves and our living powers; it is from a knowledge of ourselves as existing, and of our powers as living, that we infer the existence of the organism. How do I know that this hand, this head, or this brain are actual realities? I know it only inferen-

* Tyndall, Belfast Address, 1874, p. 18.

tially, and only because I first know, not inferentially but absolutely, the fact that I myself exist, not as a material organism, but as a conscious being. The mental picture I form of myself is of a being using its living powers; and as my conception of the external world, and, of course, of every organism, is all derived from my knowledge of what happens to myself when those living powers are used, the mental picture of myself necessarily includes my relations to outward things as I conceive them, and the outward things themselves are necessarily thought of when I form the picture.

But mental existence, not physical existence, is the one thing absolutely known to us, and though this absolute knowledge of it is limited to ourselves, it enables us to draw inferences concerning the existence of other immaterial beings as valid in their nature as any inference about physical things. All we have to remember is, that any facts concerning other immaterial beings can only be known to us through a double inference, so far as things external to ourselves only affect us through our physical senses. What is possible in mental existence we may know from our own self-knowledge, but what is really the fact beyond ourselves can only be learned by patient observation and the judgment of reason upon its results.

And here I think we may take a final and conclusive step in this important argument.

When a man addresses a single word to a fellow-creature, believing that it will be understood, he virtually abandons the materialistic doctrine, and admits that he himself possesses knowledge which the physical senses can never give. He assumes that his neighbour thinks and feels; but on what ground does he assume this? That a material object of this particular shape is there; that it moves, and speaks, and feeds; that certain acts of his own and certain

conditions in surrounding things are followed by certain changes in this object, including all the sensible phenomena of what we call human life in others; all this is conveyed to him by his physical senses. But they tell him nothing at all about thought and feeling in the object before him; and in assuming that these exist, he cuts off the very root of the materialistic philosophy, for he takes for granted that he knows something concerning objects external to himself, which it is not and could not be possible under any circumstances to verify by any appeal to physical experience.

The thoughts of his neighbours, if they have any thoughts, cannot possibly be made evident to himself in any single case whatever, and the canon of Materialism demands that under such circumstances he should have no opinion as to their existence, and should content himself with observing and recording the laws by which the outward actions of the human forms about him are governed, without pretending to know anything as to their unseen causes.

Yet we are all aware that there is no fact external to ourselves of which we have a more absolute assurance than the fact that our fellow-men do think and feel. What can the materialist say to this? He knows their forms and movements through his own favourite means; he learns them directly through the evidence of his physical senses. He sees their faces with his eyes; hears their voices with his ears; touches them with his fingers; knows that they offer resistance to his muscular sense. But his senses tell him no more about their thoughts than they do about the cause of gravitation.

If he should say he believes his neighbours have minds like his own, because he knows they have bodies like his own, I shall tell him he deceives himself. The bodily form does not give him this belief if the acts are idiotic; and he

would attribute a human intelligence to any form whatever if it gave practical evidence of human motives and purposes. I should tell him also that the co-existence of his own mind with his own body is not known to him as a necessary co-existence. He cannot learn from experience whether his mind could exist without his body, or whether similar bodies must always have similar minds.

And lastly, since experience in any case can never be conceived of as verifying the fact of thought and feeling in his neighbours, but only as verifying other facts from which this is inferred, the inference according to his principles can be nothing better than a working hypothesis, useful only so far as it enables him to predict results.

And yet in what respect does this hypothesis differ from the actual knowledge of material things, supposed to be derived directly from experience itself? That knowledge rests entirely on a similar hypothesis. It rests on our belief in the trustworthiness of memory, which is what we refer to when we speak of experience, and which is verified only as we verify our belief in the intelligence of other men; by the judgment of a living soul.

The conception of memory by the modern physical school is so important, and I think so irrational, that having here referred to it in this way I shall ask you to consider the matter parenthetically for a few moments.

Every sensation or other mental change is supposed by this school to be dependent on molecular alteration of nervous matter. This matter is conceived of as composed of an almost infinite number of connected threads, each of which is a channel of sensibility. To feel anything is to have one of these channels altered. This alteration is either permanent or not. If it is permanent, the feeling may be recalled in memory by again stimulating the same nervous channel.

Now on physical grounds the whole theory appears irrational. Firstly, because all organic substance is constantly changing, so that there is nothing permanent about it. Secondly, because to admit the idea of permanent change is to deny that memory consists in a repetition of what occurred before in the nervous substance, for this could only happen if the substance remained as before. If a stimulus passing through A, B, C, changes it into A, C, B, another stimulus through A, C, B will not be a repetition of the first through A, B, C. Yet if there is no permanent change, what is the physical fact of memory?

Still more important is it to consider that memory does not consist in the reproduction of former mental states, but in the recognition of the fact that they are thus reproduced; that the thing now thought of has been thought of before. And this is a totally different affair. Sights, sounds, thoughts, and feelings are really repeated day by day in our consciousness without the slightest memory attending the repetition. Memory depends on our perception of Time; on our conscious knowledge of a past existence; and to attempt to explain it by any physical conditions, which necessarily represent the present only, is a symptom of a false philosophy, and a science which forgets its own foundations.

Happily our practice is often wiser than our theories, and there is no reason to fear that we shall ever doubt the mental existence of our friends. And, till we doubt it, a permanent materialism is impossible. For if one thing can be known to us which is beyond the reach of sensible experience, other things of a like nature may also be known; and if we can justly infer the presence of a living soul in a human body, we may with equal reason infer the presence of a Divine Spirit in the universe.

There is one particular idea, commonly connected with

the conception of mental or spiritual beings, as distinct from material beings, which has been, I believe, a very serious impediment to sound views upon the subject. It is taken for granted that a human soul, if it has a separate existence, must also have a conscious existence independently of a human body. If you examine the argument used by Professor Tyndall, in his Belfast address, in opposition to Butler's reasoning, you will find that all its force depends upon this assumption.* The reply put into Bishop Butler's mouth is based on the same conception, as I dare say it would have been by Butler himself. But it is in consequence an insufficient and unsatisfactory reply. The true answer would be that a human soul does not require a body in order to exist, but does require a body in order to be conscious. We have no more ground for thinking that our souls could feel as they do without the help of an organised body, than we have for thinking that our bodies could act as they do without the guidance of a living soul. The facts concerning automatic action, so finely brought forward by Professor Huxley, do not affect this question.† If a frog's body accommodates itself to certain circumstances after its brain is removed, and if we really know, which however is extremely doubtful, that no conscious volition is concerned in it, the fact only furnishes one more example of involuntary action which is like voluntary action. The cases are very numerous. Nay, it is probable that everything we do of a physical kind may be done involuntarily at certain times; and habits which we are perfectly aware have been formed by the action of our own will, appear often to be like the winding up of machinery, which, being thus wound up, will carry out our purposes for a given period whether we know it or not. Habits of self-

* Tyndall, Belfast Address, 1874, p. 14.
† Belfast Lecture, 1874.

preservation are expressly of this kind. We are quite ignorant of the nature of the machinery, and are likely to be so till we discover why or how it is that bodily movements take place at all. But that our own will has a distinct relation to them, and that we understand enough of this to determine whether other men have wills and are using them, by observing their bodily movements, will, I suppose, be admitted; though we may be mistaken with regard to any one of them, if we form our opinion on too narrow a basis of observation.

The effect of bodily disease upon the mind and character is great, but all it amounts to is the well-known fact that all our conscious states are influenced by physical conditions. It does not affect the question of our own permanent identity, which does not even depend on our own recognition of it. We forget our existence every night, and our characters, by which we mean the relative force of many inclinations, vary more or less every day. But we do not cease to be the same individuals on this account.

The direct power of a human mind over the movements of matter is undoubtedly extremely small in amount, and is confined within very narrow limits of possible action. And no portion of matter is under mental control to the exclusion of other forces, so that all the movements of which it is capable may be produced by other means as well. Thus, after an ordinary involuntary inspiration, I can, by the exercise of my will, draw in more breath, which would not have been drawn involuntarily. My will in this case has caused a sort of movement which is usually caused by other means. And going to the bottom of this movement, as far as we are able, it seems probable at present that the only material substance over which any one human mind has direct control is the nervous organism of one human body.

And in exercising this control we are not ourselves aware of the substance on which we are acting. We are only aware that by some means our will is obeyed. In this respect we are not unlike the clerks in a telegraph office, who know by experience that if they do certain acts themselves a distant hand will move, though they have no real knowledge of the agency by which this is effected.

But however small the mental power over material movement may be, it is quite sufficient for its purpose. We are surrounded by infinite forces, acting or ready to act in all directions, and all we need is ability to guide a certain number of them to a certain extent. The mind, acting as a cause of change in the nervous system, is, to refer to a familiar illustration, precisely like the driver of a locomotive, who is only able himself to move the steam valve and the break lever, and who can only move even these through a very small space — a space which may be indefinitely reduced by perfect mechanical arrangements till the actual movement and the actual force employed may be inappreciable to sense. Yet this is quite sufficient. There is physical force enough in the steam and in the friction. He does not want to add anything to it; he supplies nothing out of his own strength to the forces by which the wheels are moved or stopped. He only wants to determine the direction in which those forces act, for by determining their direction he controls their effect. And those delicate movements which his own strength does bring about may also be brought about by other causes, the difference being, however, that the whole combination and series of effects which really distinguish the action of human intelligence will not be produced without it.

This seems to me the common sense explanation of voluntary activity. We may discover hereafter that even the

nervous organism is only indirectly affected by the mind, or that mental power is only able to determine the direction in which static forces can become active ones; or we may learn, on the other hand, that all force is mental, and that either small forces are partial manifestations of great ones, or that great forces are the accumulated result of small ones. These are questions of method only.

That defective psychology, which has not distinguished between the fact of spiritual existence and the power of mental consciousness, has had its origin in unscientific times, and has led to much extravagance of thought. We owe to it, for example, the notion that in sleep we are always dreaming, and that nothing once known to us can be really forgotten. Such views are only examples of the kind of thought which makes the physicist so impatient of the metaphysician, and gives Materialism an undue advantage in many discussions. They are obviously based on fancy only, and not on knowledge of any kind.

But we do know that mental existence and consciousness are not the same things as material existence and motion; and as they are not the same things, we are justified in concluding that the universe contains at least two different kinds of being, and that we, as human creatures, are made of these two kinds united. We know our bodies as a succession of moving particles, which come and go, and are never at any moment what they were the moment before. We know our living selves as permanent beings, not coming and going; changing in power and in knowledge, but remaining in identity the same from day to day. Our bodies give us knowledge of the world without, and all the consciousness we can remember is dependent on their assistance. Continually while we live, and finally when we die, these bodies go entirely to pieces, and are used up again and again

in other forms; but our mental nature being different, there are no grounds for thinking that it is either broken up or changed by death; and since it has already inhabited a body continually changing, there is no reason why some other body may not be its dwelling hereafter, giving it again the means of consciousness, and of outward communication with the universe.

Such a view accounts for all the facts known to us, in accordance with our entire experience, which Materialism can never do; and it leaves before us the prospect of a conscious life to come, as in its nature probable on strictly scientific grounds.

That science should recognise this, and teach it, appears to me absolutely essential to its own continued hold upon human interest; for consider again, What are the real consequences of the opposite view? Suppose we were agreed that only one kind of thing has real and permanent existence, and that this one kind of thing is matter. It follows, from the nature of organisation, that no organised being is a permanent being, any more than the water in a running stream to-day is the water that was there yesterday. The water may appear to be the same to others, but it could not appear so to itself if it were a sentient thing. No one will deny that one material atom cannot transfer its own identity to another, or that two different atoms, doing similar things, can never be one atom doing the same thing twice; or that, when we speak of ourselves as continuing to exist, we are not speaking of other beings; or that the question in which we feel a personal interest is, whether we ourselves shall continue to exist, and not whether other people exactly like us will exist after us. The very word "identity" would otherwise be without a meaning, and all knowledge would be illusion. And it follows that, on the theory of Materialism, to continue or to restore the lives of

human beings after their bodies have been dissolved and used again, is impossible. This world then, and the short period of our present lives, could alone be of any real concern to us; and I ask, What are the reasons by which scientific studies, and the general culture of the intellect, are in such a case to be recommended to our choice? If we choose them by nature, in preference to anything else, well and good; but if our natural choice is for other things, what is to induce us to alter it?

A man knows by the tables of mortality what his average chance of life in this world amounts to. He knows that, although he may happen to exceed the average, he may also happen to be one of those who die to-morrow. We cannot help looking before and after. We find ourselves, when we begin to think for ourselves, with tastes and dispositions already formed. We cannot act at all without a motive, and all our motives are either present impulse or reasonable purpose. What reasonable purpose can be set before our minds to make us undertake the slow labours of study, the hardships of self-sacrifice, the risk of losing all by dying while nothing is accomplished?

The question, you must remember, is not whether we should do these things if it happens that we wish to do them, but whether other wishes should be changed to these, and what is to change them. For this is the educational problem of every age. The natural desire of most men, if left to themselves, is to lead easy lives, and to enjoy present pleasures. This desire is disturbed by thoughts of a future life, or of a Divine Presence; but if these thoughts can be discarded, still more if their whole foundation can be disbelieved, what is there in the ordinary course of life to bring about a similar disturbance? Self-interest could never do it with the majority of men. The gifts and opportunities of the majority are comparatively very small, and if

the object is to make this life, while it lasts, a pleasant one, their safest way is to take things easily, and make sure of the pleasure that lies nearest. A selfish Epicureanism becomes at once the highest wisdom.

And the reasonableness of an unselfish life on such a theory cannot be successfully maintained.

No doubt there is in every human being a power of loving and desiring, for its own sake only, whatever is pure and noble and disinterested. No doubt there are many in whom this power asserts itself so strongly that it must be exercised; who of their own free choice prefer the happiness of others, and the moral elevation of their own characters, to anything else that is set before them. No doubt, also, the voice of conscience is universally heard, and is always impelling us in the same direction. But why are we to encourage these feelings when they are not naturally strong? Why are we to say to the men of lower tastes and habits, You are degrading your nature; you are wasting your opportunities; you are sinning against right and duty; if our nature, our opportunities, our conscience, are all the mayflies of an hour, and our own concern in them will end for ever when the hour is past? It is not true that the pleasure of this life is known to be increased by cultivating either the heart or the intellect. Its nature is known to be changed by such cultivation, and those who have experienced this change can no longer content themselves without it. But prior to such experience, most men can very easily content themselves without it; and who is to measure degrees of satisfaction, or show the actual balance between pleasures of different kinds? There are many savage tribes in whom the enjoyment of life is far more unmixed than ours, and what are the reasons by which Materialism would induce us to disturb their present state, and raise them, as we esteem it, into civilised beings? To store the mind with knowledge,

to quicken and purify the affections, is to create desires which this world can never satisfy. It is like planting a tropical flower in an English garden, where we know it will die long before it has time to blossom. It is like shooting arrows at the sun, certain as we are that the earth will receive them all.

And I must for a moment call your special attention to the fact that the physical theories in which Materialism finds its chief support are really speculations of the most daring kind, resting on the narrowest possible basis of verified truths.

What Mr. Darwin has discovered, for example, is that, in the present world, filled with life as we find it, the process of natural selection will account for continued change in the specific characters of living things.

What we know about evolution generally is that, within the limits of our observation, there is, in the common order of change, a very frequent resemblance to the process which we call development in the growth of living things.

What we know about the dissipation of heat is, that bodies like the earth and sun are cooling, unless there is some external source, not at present understood, from which internal heat can be supplied.

These are most important additions to human knowledge, but they are utterly insufficient to justify the theories now derived from them concerning the origin of life and the history of the universe; and science, in the meantime, while adopting these theories with dogmatic faith, is hiding, under the name of Energy, its own inability to account for the facts relating to the material world, without the help of that which is immaterial. For energy, like consciousness, is not cognisable outside ourselves by any physical sense. We know what we mean by it, but that is because we ourselves possess it, and can infer its external presence by reason of this internal knowledge.

My wish has been to impress upon you as strongly as possible the fact that a belief in two kinds of being has been universal in the world; that all the maxims of human conduct have been formed under its influence; and that in assuming that the cultivation of the human intellect is a thing desirable in itself, and in the highest degree, we are adopting axioms which have been thus produced, and for which there is at least no other obvious justification. If that fundamental belief is overturned, all its consequences go with it, and it rests with the lovers of science to show by some new method of their own why study of any kind is worth pursuing. And before replying to this challenge it is necessary to consider another and not a smaller difficulty. If there is really no such thing as immortality, and if the study of science destroys the belief in it, it leads us then to sacrifice a glorious and beneficent illusion for the sake of a painful and depressing truth. Why should we make this sacrifice? Why is it well for us in such a case to know the truth? I think we may be sure of one thing; that mankind generally would decide that it is not well. Whatever we do, our real knowledge of truth is very limited and most imperfect, and the only ground we have for wishing to know as much of it as possible is the assurance, not only that it cannot be altered, but that it is in harmony with our highest and most permanent desires. This assurance is strongly rooted in all Christian nations, but, I believe, in them alone; and it is clear that it must depend on the general view we take of our position in the universe. Science assumes that natural Truth ought to be loved for its own sake, and forgets that it owes this idea entirely to religious trust; to the conviction that all things are governed by infinite wisdom and absolute goodness, and therefore that to know what is true is to know what is best. This conviction

has become so much a habit of thought among ourselves that we forget what it rests upon, and take for granted that it needs no support. Yet who does not call the ignorance of the lower animals, concerning death and other dangers, a happy ignorance? And who does not feel that, even for ourselves, it is good to find some things hidden by an impenetrable veil? To draw such a veil over any truth, the knowledge of which could only destroy human happiness without bringing any compensation, is only common kindness to others and common prudence for ourselves. We know by the long experience of the past how fully immortality can be believed in and trusted to, under the ordinary conditions of human knowledge, and how perfectly it is fitted to satisfy and purify the desires of our hearts; and if it were a fact that it could never be enjoyed, our wisest course would be to retain the happiness of that belief, and for this purpose to prevent, if not for ourselves at least for our children, the pursuit of studies which led to its rejection. Thus it is, happily as I think, that Materialism will always defeat itself, by turning men away from any form of science which evidently involves the acceptance of its doctrine. And it is therefore in the supreme interest of science itself that I recommend its present tendencies to your earnest consideration. It is a matter on which the leaders of science should speak their whole minds without hesitation. It will not do to say, as is so generally said, We study the physical world, and leave other matters to other men, unless it is plainly shown that these other matters are not affected by the results of physical research. And when, on the contrary, those results as interpreted by science are seen by every one to have the most direct and momentous bearing upon the deepest interests of human nature, there is a cold and forbidding cruelty in the science that will calmly dig about the foundations of our dearest hopes, will lead us

to infer that they have little or nothing left to stand on, and will quietly stop there, taking no pains to learn whether the destruction is real or whether it has been necessary.

I do not say that science is alone to blame in this matter. The fault lies equally with theology. It was the constant habit of theologians, a few years ago, to deny the truth of facts that had been verified, while they assumed the truth of other facts that could not be verified. The human mind was supposed to be capable of deciding correctly, by a kind of instinct, whether particular events had happened or particular words were spoken in ancient times; and decisions arrived at in this way were held to have a higher validity than inferences drawn from the patient observation of existing facts. Against such habits of thought the scientific spirit is necessarily and always absolutely opposed, but they are equally inconsistent with the religious spirit, which desires to know the truth as earnestly as science does, and is even more deeply interested in avoiding the pitfalls of false reasoning. But theology, which, in needless alarm, had closed its gates at first against what seemed to be a host of enemies, is opening them again to the reinforcements of its truest friends; and the present danger is that science will remain outside, in a position of cold antagonism, sacrificing its own best interests to the materialistic idea.

Science in other days has held a noble and sacred office, strengthening and elevating by its discoveries the conviction of a divine presence in the universe, and of an immortal future for ourselves; exposing many errors, correcting many prejudices, teaching modesty, tolerance, and patience to our reasoning powers, but maintaining always the essential truth that there are two kinds of Being, and the fact that, while our own mental existence is absolutely known to us, the presence of any bodily organs can only be inferred. If this conception is abandoned, we stand indeed upon one

bright spot of life; but there is an abyss of endless darkness into which, within a few short years, every one of us must take his final plunge. The universe becomes dreadful in the presence of that yawning gulph, and he is wisest who sees the least of it, and who can hide the future in a golden haze of present pleasure till the moment when he drops away. Not such, however, is the true teaching of science in a world like this. It is the closing of our eyes, not the keenness of our vision, that brings such phantoms into view; and the first fresh flower, the first sparkling dew-drop, the first smile of a friend or a little child will take us back to the grand realities of nature, if we look at them in the light of a sound philosophy, and see them as they really are.

POTENCY IN MATTER.

By the Rev. H. H. HIGGINS, M.A.

The title of the following Paper may have suggested that its purpose is the discussion of Materialism, more especially in connection with certain announcements made during the proceedings of the British Association, on the occasion of the late meeting held at Belfast.

My motive in bringing the subject before you is definite. Without sharing in the apprehension prevalent in some quarters that the Belfast addresses will promote the spread of materialistic views, I have a very distinct fear that they may have a prejudicial influence on the study of natural science in its entirety. Right or wrong, hundreds of teachers will use Professor Tyndall's discourse to point a moral: see what comes of over-much scientific learning! Those most likely to suffer loss and discouragement are therefore, my especial clients, the beginners; in whose behalf I would fain dispel any possible doubt as to the thorough trustworthiness of nature, however deeply interrogated. It will, then, be my endeavour to show that nature is fully competent to deal with, and to rectify, all misapprehensions which may have arisen with reference to materialism, and its postulate—potency in matter.

Professor Huxley, at the same meeting, is reported to have said, "Let me ask you to listen to another product of that long experience to which I referred. Logical consequences are very important, but in the course of my experience I have found that they are the scare-crows of fools, and the beacons of wise men. Logical consequences can

take care of themselves. The only question for any man to ask is, Is this doctrine true, or is it false? No other question can possibly be taken into consideration until that is settled."

Professor Huxley asks a hard thing. He demands that all logical consequences of a doctrine should be strictly excluded from sight till we have decided as to the truth of the doctrine itself. Now absolute certainty is rarely attainable in any question; but in arriving at the high degree of probability which serves us in its place, we are frequently aided by conclusions anticipated pending our decision. This is not the most perfect, but it is often the only practicable method. Few inductions are, at any given period of their history, so perfect as to be quite independent of the consequences which may thereafter be found to be logically deducible from them. Even Euclid, in proving that if the extremities of two straight lines coincide, the lines themselves coincide and are equal, anticipates a logical consequence which he uses to show that no other supposition is tenable. In the building up of the doctrine that animals are automata, logical conclusions were by Professor Huxley freely used in support of the process by which the theory was being constructed step by step; indeed it could not have been even attempted otherwise; yet when the doctrine is before us, the character of an ultimatum is claimed for it—it must not be judged of by any ulterior logical consequences whatever: the strong arm here seems for once to wield the back of the axe.

I have been accustomed to regard logic as a kind of verbal algebra, yielding infallible results when subject to the condition that the word-symbols used in logic must adequately represent the things for which they stand; a condition, the disregard of which frequently vitiates the results of the logical method when applied in Theology and Meta-

physics. But a slur cast indiscriminately on logical consequences would leave us all in intellectual darkness: an event by which few of us would, I suspect, be greater losers than Professor Huxley himself. The reason for this apparent digression will appear as we proceed.

It is towards the close of his address that Professor Tyndall makes the following announcement: "Abandoning all disguise, the confession that I feel bound to make before you is that I prolong the vision backward, across the boundary of the experimental evidence, and discern in that Matter, which we, in our ignorance, and notwithstanding our professed reverence for its Creator, have hitherto covered with opprobrium, the promise and potency of every form and quality of life." (Page 29, *B. A.* ed.)

This is no more than—indeed, it is not nearly so much as—he said in his address when the British Association last met in Liverpool.

It does not appear that we should gain much at present by discussing the exact significance of the words "promise" and "potency." Weightier matters than mere verbal criticisms demand our attention. In fact, the doctrine of the promise and potency of matter is only an emanation, one of many, derived from a deeper and a less conspicuous source lying enshrined in the axiom that "*physical theories which lie beyond experience are derived by a process of abstraction from experience.*" (2nd edit. p. 52.) This, and this alone, is the true nucleus, the pineal gland, of the whole address.

On the character of this process of abstraction from experience, the doctrine of the promise and potency of matter entirely rests. Whether, moreover, this same process is on the whole reasonable, or whether it is equivalent to a plunge in the dark, depends on subtle and extended considerations. The very nature of the axiom precludes a trial by experiment, for, by hypothesis, its sphere extends beyond experience. It

is not a step into the border land, confessedly so mysterious, between the material and immaterial worlds; no, it is a passage from experimental physics, to *physics*, mark, beyond experience. There ought to be nothing hazy, or ill defined, or incapable of being fully illustrated, in the whole of the transition. The man of science ought to be at home every step of the way, for he claims that it lies wholly within the domain of physics.

The formal announcement of this most pregnant axiom, on the 52nd page, 2nd edit., opens by a reference to the beginning of the address, where accordingly we find that the way to arrive at physical theories beyond the pale of experience, by a process of abstraction from experience, is a very ancient way; that it was trodden by our earliest historic ancestors; and that it led them to assign the rule and governance of all natural phenomena to a species of creatures exhibiting all human passions and appetites. (2nd edit., p. 1.) Not a very encouraging commencement, certainly; but rather one which suggests the expediency of vigilance as to whither the same path may lead ourselves.

More than the first half of the address (2nd edit.) is occupied by the history of the theory of atoms, down to the time of Bishop Butler. We must, I suppose, submit to be taught even as our great teachers think fit to instruct us. But we have had a weary spell of Epicurus, and Lucretius, and Democritus, and Descartes. The sermons of Bishop Laud and Bishop Andrewes are scarcely more Patristic than the discourses of some of our most advanced Physicists. No doubt the narratives are interesting, and the style in which they are told is masterly; but whilst we have the spectacle held before us, to say the least, of life and death weighed in the balance; whilst we are burning to know what are the very latest advancements of science in a region so adventurous as that of metempyrical physics, these preliminary

pious libations at the shrines of departed learning are, such is human weakness, somewhat trying.

But perhaps, after all, they may be to the point. Let us turn then to Lucretius, whose theories occupy the most prominent position. The following is an example, quoted with admiration in the address, from the poem of Lucretius, "On the Nature of Things:" —"From all eternity they (the atoms) have been driven together; and after trying motions and unions of every kind, they fell at length into the arrangements out of which this system of things has been formed." (2nd edit., p. 9.) This is not the place to discuss the Lucretian cosmogony, except so far as to enquire whether Lucretius can be justly cited as a pioneer of science on the road from experimental to ultra-experimental physics. Why, the acquaintance of Lucretius with experiment was scarcely beyond that of an infant! It was the discovery of the laws of chemical combination, and the recognition of the true character of molecular force, which first rendered possible a scientific conception of atoms; and without this no theory of atoms can form a part of science, or be anything more than a speculation. On this point, therefore, his example is of little weight.

The address tells us that Lucretius combats the notion that the constitution of nature has been in any way determined by intelligent design. Nature, according to Lucretius, is seen to do all things spontaneously, of herself, without the meddling of the gods. If by the gods we are to understand Mars, Bacchus, Apollo, and the rest, all honour be to Lucretius! There is no doubt that Epicurus and his disciple Lucretius strove earnestly to convince their followers that the order of nature was not controlled by the gods of the popular mythology. At the same time, it is certain that Lucretius taught that not any thing occurred, or had occurred, by chance; and it is probable that he both

admitted and taught the existence of One Supreme Power. *Vide* Book v., l. 1250.

> "Usque adeo res humanas VIS ABDITA quædam
> Obterit."

Which has been rendered—

> "So from His awful shades some Power unseen
> O'erthrows all human greatness."

The possible connection between the "*vis abdita quædam*" of Lucretius, and the inscription "To the Unknown God" on an altar at Athens, read by St. Paul, and referred to by him as pointing to the God whom he came to declare, as "the God who had made of one blood all nations of men, and had determined the times before appointed and the bounds of their habitation" ("*res humanas*"), has been critically examined and confirmed by John Mason Good, in his translation of Lucretius. The altar alluded to by St. Paul may have been erected so long before the Apostle's time (about a hundred years) as the sojourn in Athens of Lucretius, who may therefore have seen the very altar.

The controversy on the Theism of Lucretius has been extensively and ably conducted on both sides. But if Lucretius cannot be fairly cited, either as a man of science or as an atheist, why is so much valuable space taken up with his speculations?

A statement of *some* of the difficulties involved in the materialistic theory is, by Professor Tyndall, suppositiously assigned to Bishop Butler. It is only fair to say that the address places *these* difficulties in the strongest light. In his supposed discussion with a disciple of Lucretius, the Bishop thus proceeds:—"Take your dead hydrogen atoms, your dead oxygen atoms, your dead carbon atoms, your dead nitrogen atoms, your dead phosphorous atoms (Is the professor illus-

trating his idea of the ordinary form of episcopal eloquence?), and all the other atoms, dead as grains of shot, of which the brain is formed. Imagine them separate and sensationless; observe them running together, and forming all imaginable combinations. This, as a purely mechanical process, is *seeable* by the mind. But can you see, or dream, or in any way imagine how, out of that mechanical act, and from these individually dead atoms, sensation, thought and emotion are to arise? You cannot satisfy the human understanding in its demand for logical continuity between molecular process and the phenomena of consciousness. This is a rock on which materialism must inevitably split whenever it pretends to be a complete philosophy of life." No reply is attempted in the address; but it is added further on (perhaps on a principle which has been recommended in cases of forensic difficulty), that the bishop boldly embraced the whole animal world in his scheme of immortality.

The address proceeds to notice a variety of subjects, the most important of which are the geological record, Mr. Darwin's theory of natural selection, the theory of evolution, that of the conservation of energy, and the philosophy of Mr. Herbert Spencer. All these are branches of knowledge affording, no doubt, examples of the true application of the great axiom that "physical theories which lie beyond experience are derived by a process of abstraction from experience." Far, however, from supporting the particular doctrine of the address touching the derivation of all forms and qualities of life from matter, the magnificent inductions of science, even when they extend beyond experience, may, I think, be found, by way of contrast, powerfully to oppose this doctrine.

Take, for example, the immense age of the earth's crust. You need only be reminded of the multitude of facts, chemical, astronomical, biological, meteorological, in long array,

which converge in support of the theory, that countless ages must have elapsed since the earth assumed its present shape. Whereas, when we turn to the doctrine of the potency of matter, we are met by the admission that matter has never yet shown itself capable of producing life, even as it is exhibited in the lowest organism. (2nd edit., p. 56.)

Allowing, for the sake of argument only, the complete success of the experiments on the origin of life, familiarly associated with the name of Dr. Bastian, all that follows is that life may begin in the absence of previous life. In these experiments certain eliminations have been as far as possible secured, in virtue of which it has been asserted that life in the test-tubes must have arisen through the potency of matter, because of the *impossibility of accounting for it in any other way.*

In reply it may be urged, Why assume that it can be accounted for? Life is continually presenting us with facts which we cannot explain on any hypothesis. Why does one drug act on the stomach, another on the liver, and a third on the lower intestine? We never think of saying, It must be because of this, or because of that, since it is impossible to account for it in any other way. No; we pocket our ignorance quietly, because it is notorious that we cannot explain these results in any way. It is not till we hunt down life to its lowest representative, in the form of a Bacterium in a sealed test-tube, that we take courage, and in the presence of such mites say, Here is life; behold the potency of matter to produce life; it must be so; it cannot be accounted for in any other way! If a Bacterium could speak, its utterances might not be complimentary to our sagacity.

That you should discern in matter the promise and potency of every form and quality of life (including the highest development of the human intellect), seems a large demand; but far less than this will no doubt

satisfy the claim of the most ardent materialist; go with him a single step, admit the potency of matter to produce an animated microscopic speck of jelly, and he will shake hands with you, and politely consign you to the care and guidance of an evolutionist for the remainder of the journey. It is, in fact, the assumed completeness of the work of the evolutionist that makes the materialist long to take the single step essential for the junction of the two roads. (*Address*, p. 54, 2d. ed.) "Trace the line of life backwards, and see it approaching more and more to what we call the purely physical condition. We reach at length those organisms which I have compared to drops of oil suspended in a mixture of alcohol and water. We reach the *protogenes* of Haeckel, in which we have a type distinguishable from a fragment of albumen only by its finely granular character. Can we pause here?"

Now because life may animate a speck of bioplasm or organisms small and simple as spherules of oil, is this any the more life itself approaching the purely physical condition? To claim that it is, is at once to beg the whole question.

But, we have to consider more especially the appeal, Can we pause here? Here, where the lower extremity of the grand series of living things lies so invitingly within reach, and where the fastening of just one little link would be the annexation of the whole? It is evident that a very close continuity is assumed to exist in the downward series, from the highest to the lowest of living things; a continuity alleged to be in strict accordance with experience, and indicating a continuity between animate and inanimate matter, confessedly beyond the pale of experience.

Now this kind of continuity I cannot find, and I therefore venture to suggest a consideration which may be expressed in the words of the following formula: — THE

PRESENCE OF LIFE INTERRUPTS, WITH EXCEPTIONS AND DISCREPANCIES, ALL THEORIES PROFESSING EXHAUSTIVELY TO INTERPRET ITS SEVERAL PHENOMENA.

Believing earnestly that truth *is* best, I am anxious to have this *formula* freely examined, as being the foundation of the greater part of what I have to say. Its bearing is not directly in opposition to Professor Tyndall's "continuity;" and, if established, it can only render "continuity" extremely improbable.

It will not, I think, be denied, except perhaps by the extreme advocates of certain schools, that the whole region of mental philosophy is a storehouse of illustrations confirming the truth of the foregoing position. Is it possible to look upon the works by which the names of such men as Berkeley and Hamilton and Immanuel Kant are known to mankind, without feeling that to apply to their explanations of a single mental fact the term *exhaustive* would only be sad irony? Yet what is this but a paradox, if mind and its emotions spring from and consist of forces yielding themselves to the methods of exact analysis? But our appeal is to be made, not to Philosophy, but to Nature.

To begin, then, with the great theory of evolution. No sooner is the study of Nature approached with intelligence, than a want is felt which evolution claims to supply; nor is the claim presumptuous. The evidence by which evolution is supported is cumulative, and may be found in all regions and in all ages of the world. Without evolution nature would be comparatively barren in instruction; and many of the most exquisite truths of science,—such, for example, as those classed under the head of homologies, those also relating to the geographical distribution of living forms, and very many others,—without evolution would be a mere unintelligible medley. Is it to be wondered at that men of science are jealous for the honour of a doctrine so prolific?

Nevertheless the facts which range themselves on the side of positive discrepancies are many; and the residuary facts which refuse to be explained by evolution are at least as numerous. It would of course be as vain to attempt to point out, within the compass of a short Paper, the difficulties which attend the doctrine of evolution, as it would be to pretend to exhibit the evidence producible in its support.* But I would ask, How is it that there should be such difficulties, and whether their existence is not a significant fact?

Difficulties do not, so far as I know, beset in any like degree theories relating to things without life. Theories in Astronomy, Chemistry, Light, Heat, Magnetism, Acoustics, etc., work smoothly enough. But it is notorious that the very highest authorities in education sparingly recommend the study of Zoology or Botany; it may be for this simple reason, that in these subjects a lecturer may lay down a principle to-day, and to-morrow his youngest pupil may bring him a specimen completely at variance with it.

Geology, as I have already remarked, requires an immense lapse of time to account for the deposition and succession of rocks. Biology also requires a remote past for the evolution of species, and thus far the two are in agreement; but, on comparing notes, Biology is found to require for the evolution of species, on the principle of the survival of the fittest, a time so out of all proportion longer than Geology in consultation with Astronomy can afford to admit, that a most serious discrepancy arises; and I believe that whilst geologists are evolutionists almost to a man, very few geologists who are also palæontologists are disposed to

* For a fair statement of some of the difficulties affecting the theory of evolution, see *On the Genesis of Species*, by St. George Mivart, F.R.S. Also, a brief reference to some of them, in *Introduction to the Study of Biology*, by H. Alleyne Nicholson, F.G.S.

admit that the phenomena of life during past ages can be adequately accounted for by the doctrine of evolution.

In the beautiful theory, ancillary to evolution, known by the name of its originator, Mr. Darwin, we have a true calculus, which, when applied to large numbers of biological questions, solves them as Newton by his method of fluxions solved the secrets of the planetary orbits. Perhaps no great theory, during the life of its author, ever gained such wide acceptance as the theory of the origin of species by natural selection; but the more convincing the theory, the more significant the existence of very many unconformable facts.

Animal and vegetable physiology presents a striking illustration of the true course of science where life is concerned. Abounding in significant and instructive principles, it seems to be fairly on the way to the renunciation of every pretension to lay down a single exhaustive or perfect explanation of a function in which life is a factor. Renunciation, I say, because the older works on Physiology afford many examples of theories supposed to be of universal application.

Systematic Biology, including the principles of classification in Zoology and Botany, has exhausted the efforts and occupied the lives of a host of observers, from the days of Linnæus to our own times. The results of their labours, so far as they have been represented in a printed form, would constitute an extensive library. It is bewildering to think of the amount of brain-work expended on the classification of animals and plants. Later writers have had the full advantage of previous contributions; system after system has been constructed and reconstructed, amended and enlarged, and with what result? Systematisers have indeed generally shown no lack of confidence in their own work; yet from the time of Lamarck, who asserted that if Nature did not correspond with his system it was not his fault, to

Haeckel, who seems in classification to be what Wagner is in music, all have more or less obviously failed. Are the Botanists satisfied with their Natural Orders, or with any divisions of lower rank? If it be too much to expect species to be well defined, are Families more satisfactory, or even the great primary divisions of Exogenous and Endogenous plants?

When we have stated that Botanists are in advance of Zoologists in classification, and that with higher forms of life in the animal kingdom are associated greater and more complicated difficulties, it might be inferred that the whole range of systematic Biology was a scene of hopeless confusion. Nothing can be further from the truth than such a conclusion. The field is very extensive: more than three hundred thousand living forms are known, supposed to be specifically distinct, and amongst these the instances of apparent anomaly bear no comparison with the illustrations of manifest order and arrangement. It is the unmistakable existence of plan that renders unconformity at once conspicuous and strange. Sub-kingdoms, provinces, classes, orders, families, genera, and species are certainly no mere fanciful conceptions, and yet I think I have never made one of these divisions an object of close study without finding a want of exactness. If life were the orderly flow of molecular forces, which know absolutely nothing of exceptions, whence all this irregularity?

The evolutionist may ask, How can there be freedom from inconsistencies in systematic biology until classification is founded on genealogical affinities? He may affirm that our much-vaunted order and conspicuous plan is nothing more than the cropping out of arrangements wrought by evolution far below the surface. Most sincerely do I sympathise with this appeal, so far as it relates to the advantage of a developmental basis. A system of classification founded

on the facts of evolution would be more instructive, would approach more nearly the order of nature, than any other; but when the evolutionist claims that his theory, if it could be carried out in classification, would eliminate incongruities, he must be told to put his own house in order, to meet the difficulties which interfere with his own theory, before he claims that it is capable of being a foundation, in systematic biology, for universal completeness.

It must, I suppose, be obvious that to myself, limitations and even irreducible facts, appearing to affect a theory, do not necessarily destroy its value: for what is a theory? Not a master but an instrument of the understanding, helping us to connect facts, and to receive instruction from them which they, the facts, in an isolated condition could not afford.

A probable objection may arise here. If imperfections in physical theories are significant and instructive, then in former times, when they were more abundant, they must have been more instructive. This is quite true. Theoretical imperfections, when recognised, have ever been the surest guides to theoretical improvements. But it may be asked, What is to be done with an imperfection which appears to vitiate the theory itself? I reply, that a theory is always good for just as much as it will explain, and for no more. If it will account for a hundred facts, why then it does account for them, not the less because it will not account for the hundred and first.

If it were possible to find a chronometer which kept perfectly accurate time for 364 days, and gained an hour on the 365th, for many years in succession, such a chronometer could not be regarded simply as a badly constructed instrument. There would be a certainty that the irregularity pointed to some other cause than mere defects in the workmanship. It is thus with theories in science. Only very

recently have we known enough of physiology and evolution and natural selection to gather anything from irreducible phenomena. Let our knowledge be steadily advanced, driving the unexplained into narrower and still narrower limits, the teaching of the unexplained will only be heard the more distinctly.

When potency of life is in the *Address* ascribed to matter, a course is followed which for some minds seems to possess a fascination almost irresistible: perfection is claimed for that which is only an instrument. I quote the words of the *Address* on the origin of living forms (2nd edition, p. 54): "We need clearness and thoroughness here. Two courses, and two only, are possible. Either let us open our doors freely to the conception of creative acts, or, abandoning them, let us radically change our notions of matter."

We may, I think, respectfully but very decidedly decline the position assigned to us on either horn of the dilemma. As to matter, we prefer to go just so far as science can lead us, but no further; and, though conscious of deficiency, we are not sure that such companionship must involve a radical change in our notions of matter. As to opening our doors freely to the conception of creative acts — I speak for myself — the door stands already wide open, but not to all kinds of conceptions. If Nature teaches that there has been, and still continues to be, creation by law, this seems to be a worthy, though it may not be an exhaustive, conception of creation; and as to clearness and thoroughness, many will think that, on such a question as the reception of Materialism *in toto*, it is better not to be bound to a theory which cannot bring a single positive fact for its support.

We have now to notice two of Professor Tyndall's illustrations, consequent on the axiom that physical theories

which lie beyond experience are derived by a process of abstraction from experience. The first relates to the structure of living things, the second to the origin of the life with which they are endued. *Address*, p. 53: "Thus (in the definite forms of crystalline architecture) molecular force becomes structural. It required no great boldness of thought to extend its play into organic nature, and to recognise in molecular force the agency by which both plants and animals are built up."

Why, yes; no doubt every part of every plant and of every animal is built up by the agency of molecular force, and so, I suppose, is every part of every table and of every chair, the forms of which have as much to do with crystalline architecture as have the forms of animals and plants. Even the minutest parts of every organism are constituted not otherwise than by the same molecular agencies which have built up the crystal. But who would not understand that the analogy was designed to extend much further than this, and to teach that the organs of animals and plants are differentiated and specialised by the same kind of molecular agencies as those which determine the cubes and prisms, the hexagons and dodecahedra of crystallised minerals? But can a crystal assimilate substances foreign to itself, as living beings do? Can a crystal exhibit the special advantages to itself of its angles, its planes, or their replacements, as living things can exhibit in respect of their organs? Can a crystal do any one thing else but increase in size externally by homogeneous accretion? And is this really the nearest approach, the best work, that molecular force can exhibit *within the pale of experience*, when claiming to be credited, through a process of abstraction, with the construction of a hand, an ear, an eye, or a nerve?

Objection 1. If molecular forces build up all the parts of an animal or a plant, then, since the whole is made up

of its parts, molecular forces construct the whole. Certainly they construct the whole without exception, just as they construct a honeycomb, which nevertheless would not make its appearance but for the assistance of the bee.

Objection 2. Is it possible to conceive the interference of an immaterial influence with the development of the material parts of an organism? In other words, expressing *the same thing*, but more accurately, Can the relations between certain molecules be affected by that which is not subject to like conditions with the molecules? I think it may be so, the theory of the conservation of force to the contrary notwithstanding. Perhaps the two may not be irreconcilable; but if they be, the question, in the present state of our knowledge, seems to involve a balance of probabilities. It appears to me a greater improbability that molecular forces alone should from a seed develop its proper plant, than that life should present an exception to a theory which has never been proved to hold good in the phenomena of life. In estimating, according to the materialistic hypothesis of the development of an acorn, the potency of cosmical force, certain eliminations are indispensable. (1) Every form of that which has been distinctively called "vital force" must, of course, be excluded. (2) Environments have obviously no voice in the decision whether a given seed shall produce a poplar or an oak. (3) The whole history of the evolution of an oak from a zoospore, through myriads of generations, cannot touch the question, except through the physical properties of the individual acorn from which the tree grows. (4) The extreme complexity of the molecules in colloidal forms of matter has been suggested as a reasonable ground for a theory of the physical construction of organs; but between the theory and its establishment, not one link only but many links are missing. (5) Heredity, on which great stress is justly laid, except so

far as it is physically represented in the acorn, must, by a consistent materialist, be regarded as nothing more than a "*pestilent abstraction.*" When these five eliminations have been made, there remain for the materialist only the acorn with its inherent properties, and the action of the purely impartial molecular forces, wherewith to work out the problem of the oak, with its innumerable specialities, including the development of a future acorn similar in all respects to its predecessor. In this light the materialistic theory of the construction of organs appears to demand the most unexceptionable confirmation; and to dogmatise, by announcing as scientifically settled (see "Body and Mind," *Fortnightly Review* for December, 1874) questions on which the presidents of the British Association for the last six years are about equally divided *pro* and *con*, is to adopt a course to be regretted by the lovers of truth on both sides.

Difficulties have to be met on either hand, but if the choice *must* be made it seems the less difficulty to give up, in connexion with the phenomena of life, the absolute inviolability of the equilibrium of force. If then conscious volition initiate the raising of a weight, life force, which may be a kind of unconscious volition, may surely initiate the guidance of a molecule. Yes, but volition is a product of molecular force. Very well; only remember that that doctrine is entire materialism, which can be respected only when it is consistent; so let it be remembered, there must be no shifting of the ground presently.

On the 55th page of the *Address* occurs the memorable illustration touching the origin of life: "We break a magnet and find two poles in each of its fragments. We continue the process of breaking, but, however small the parts, each carries with it, though enfeebled, the polarity of the whole. And when we can break no longer, we prolong

the intellectual vision to the polar molecules. Are we not urged to do *something* similar in the case of life?" The word "something" is in italics; but as the question has no pertinency whatever in connection with what goes before it, if no stress is to be laid on the word "similar," we have first to enquire, Is what we are urged to do in the case of life similar to the process with the magnet of which we have just read?

Now, in point of fact, it does not appear that the theory of the polarity of molecules was arrived at through any such a process as that of the dichotomy of a magnet. If I mistake not, it was the result of investigations into the solid, liquid, and gaseous states of matter; in which case, the illustration of the magnet was an afterthought. This point, however, is not essential.

On the other hand, it is altogether indispensable that we should be able to recognise in the polarity of the molecules a true representative of the polarity of the magnet; without this the series would have no continuity, or rather the last supposed term would not belong to the series at all. The broken fragments of the magnet, however small, have poles; it would be absurd to say, extend the division indefinitely, and recognise the molecules as having something quite different, or no polarity at all.

What, then, is the something *similar* we are to do with life? We are to follow it down lower and lower, till we reach a speck of bioplasm. In the magnet series, the common factor is polarity. In the present series, the common factor of each term is life. Whither are we led? Surely, when we prolong the intellectual vision, we are to behold life in the molecules: H_2O, CO_2 and the rest are alive! It is a point to be taken into serious consideration by humane chemists.

But not so. We are quite wrong. This is not the

right course of abstraction from experience. We must begin again. Life in the man; life in the monkey; life in the mouse; life in the mite; life in the monad. Now we are to prolong the intellectual vision, an operation which really suggests a species of intellectual *craning*, after a run across the open of experience. We are brought up at life in the monad; abstraction carries us over, and we find — life nowhere! We are landed on the miry ground of potency of life in lifeless matter. The similarity between all this and our process with the magnet might have escaped us, but this abstraction from experience is a curious thing.

In the Belfast copy of the *Address*, the summing up is thus commenced: "Abandoning all disguise, the confession I feel bound to make before you is, that I prolong the vision backward across the boundary." In the second edition it is, "By an intellectual necessity I cross the boundary." The difference is not very great. Either of the two may fairly be regarded as challenging the attention of the reader to the idiosyncrasy of the author, certain of whose characteristics are illustrated without disguise in the *Address*, in which we may discern an intense love of theory,—that last infirmity of scientific minds,—rendering the ascription of completeness and perfection to the object of the author's profound admiration an intellectual necessity. There also may be detected an ideal temperament, displaying itself in the occurrence of conceptions more poetical than scientific, some of which are expunged in the second edition, and probably accounting for the fact that, in an address of sixty-five pages, not half that number of lines are devoted to the real point of chief difficulty. Even at the risk of somewhat damaging the symmetry and artistic beauty of the *Address*, it would have been better to have cleared away, as far as possible, the obscurity which besets that last step from the firm ground of experience to the doubtful regions of abstraction.

Potency of life in matter is inferred, but not explained, though there are assignable to the word "potency" at least the two very distinct meanings, "capacity" and "capability." For myself, I have absolutely no theory of life to uphold. If there be any consistency in the views I have expressed, a theory of the nature of life is simply impossible, even as a theory of the nature of a First Cause is impossible.

The long list of names, enough to fill a page, by which vitality has been designated, need excite no surprise. Form a theory about it, and it is certain that in doing this you are adopting a more subtle, but a very genuine, kind of materialism. Theories admit of many gradations; one may refer to mass forces, a second to molecular forces, a third to modes of motion in the ether which pervades all space. Construct a theory of vitality, and you simply add another to the same category.

For a long time the theory of the physical basis of life was to me a great difficulty. "No life without protoplasm," said my friend, Professor Huxley, for whose facts and mode of expressing them I generally entertain a profound respect. No life without protoplasm! Here, then, was an answer to my proposition that life admitted not of a direct and perfect predicate. Craving your kind indulgence for the introduction of a personal peculiarity, I may say that so certain did it seem to me that this great doctrine would be found to be no exception to the general rule, that I would sooner have discovered a living animal or plant, though no bigger than a diatom, without protoplasm, than I would have been destined as the first man to reach the North Pole. The solution was to arrive in another way, and did arrive chiefly through a valuable work just published by my friend, our respected fellow-townsman, Dr. Drysdale, on the *Protoplasmic Theory of Life*. As therein stated, the following may be gathered

as the view of bioplasm, or living protoplasm, held by Dr. Lionel Beale. Bioplasm is clear and transparent; it never exhibits structure; it is in a state of combination totally different from that which it assumes at the moment of death. Its dead remains are fibrin, albumen, fatty matter, and salts. These things do not exist in the matter when it is bioplasm, but as the latter dies it splits up into these four classes of compounds." Why, then, bioplasm is not a *thing* at all, it is masculine or feminine, probably both, but neuter never! Protoplasm is, then, not the physical basis of life, but the physical basis of some utterly unknown compound, in association with which the phenomena of life are manifested. Now, therefore, if life be a property, it is a property of a substance as unknown as itself; and to say, "No life without protoplasm," is to say no more than "No life without oxygen," or no life without carbon, which may be very true, but is not very significant.

I venture, moreover, to think that Professor Huxley's doctrine, that animals are automata, affords no ground of triumph to the Materialist. With admirable lucidity and precision, the Professor traces the actions of animals to a property inherent in living muscular substance, which is termed contractility. The nerves of sensation receive, from without, an impression which is by them transmitted to the brain, or to its spinal continuation, from which, by a process termed reflex action, which in a large number of instances is shown to be wholly independent of volition, a stimulus is conveyed by the motor nerves exciting the muscles to activity. How does the impression reach the brain, and become reflected to the muscles? By a series of undulations or waves of molecular change, as sound is transmitted through a long metallic rod. But what is the nature of this current? Is it electric or magnetic? Is it heat, or any known mode of motion? We know that it is not trans-

mitted instantaneously; is that any help to the understanding of its nature? And what is contractility? I thought that, in his Edinburgh Address, Professor Huxley had pronounced all the "*itys*" odious. It seems to me that, when we take into account the complexity of the results of the transmitted nerve current, all that is at present known of molecular physics cannot help us to a conception of nerve currents that is not hopelessly superficial. In the very simplest of what are termed automatic actions is involved a power the nature of which is utterly unknown.

Now what are automata? Some of us may remember the automaton chess-player. It was more than a nine days' wonder, and most elaborate treatises were written to account for its action. Mechanicians, opticians, and men learned in all branches of science, came and played chess with it, and were both beaten and puzzled. At length, after public astonishment had been excited to the highest pitch, it was discovered that concealed within the figure was a clever living chess player. The indignant cry arose, O then it is not an automaton after all! Now was not this cry very unreasonable — surely it was an automaton? Why, there was a man inside! Certainly, what of that? The figure acted from within itself — what was expected that the chess-playing figure did not fulfil? Oh, it was thought that wheels and pinions and wires and pulleys and rack-work and levers were doing it all; things which a clever mechanician could take to pieces, and put together again, and understand. So because there was something at work inside beyond mere mechanism and mechanical adjustments, it was not an automaton? Certainly not; according to the generally understood meaning of the word, it was not an automaton at all.

That even plants are automata may be denied as reasonably as a mathematician may refuse to regard as a true root of an equation any result, however elaborately obtained,

which involves an unknown factor, such a factor being invariably present in the economy of a living plant.

Writing on the same subject in the *Contemporary Review* for November, Professor Huxley asserts: "The feeling we call volition is not the cause of a voluntary act, but the symbol of that state of the brain which is the immediate cause of that act." Certainly, the state of the brain is the immediate cause of every voluntary movement; but what brings about the state of the brain at the time of the movement? Impressions, past and present, received through the nerves of sense.

Of such impressions, the strongest example occurring to me is that made upon the brain of a man who may unwittingly have thrust his hand into a fire. Conscious volition has probably very little to do with the immediate withdrawal of the hand. The brain acts energetically, almost instantaneously, and almost irresistibly. Now let the conditions be somewhat different. A man rushes into a room on fire to save the life of his child. Storms of impressions are driven through the sentient nerves from every part of his body to the brain; his flesh is in torture; his eyes are blinded; he has spasms of suffocation; and all this nerve-storm impinges on a brain so sensitive that it sends an active charge to the muscles on the mere touch of a feather on the cuticle. And by the theory that reflex action tends to produce results co-ordinated for a special purpose, the thousand forces of the fiery torment have a single resultant, urging contractions and extensions of the muscles "making for" immediate escape. What happens? The man gasps and endures; his brain bids the muscles make the fingers grip the burning obstacles; in spite of the raging nerves, bids the muscles themselves char and be consumed; bids them, nevertheless, make the quivering hands reach and clutch the prize; and then, but not till then, the man flings

himself and his charge through the nearest door, and ends the act with a sob and a kiss.

Is this the act of an automaton? On the automatic theory, volition was not the cause, it was only the symbol of the state of the brain. That the brain executed the necessary movements I admit, but cannot admit the clause defining volition as a mere symbol, or as Professor Huxley expresses it, as the sound of a clock bell, indicating the position of the works within.

Let us endeavour to follow out the case on the automatic hypothesis. The brain executed the movement; so far we are agreed. But portions of the brain in the burning room were in a condition ready to transmit raging reflex currents; and if any one wishes to know the strength of one such current in moderate action, let him hold his finger in the flame of a candle. It is inconceivable that these portions of the brain could overcome their own tendencies, for then the same matter would be in two states at one and the same time.

It follows that other portions of the brain must have been dominant on the occasion by an excess of power sufficient to coerce the ordinary sources of reflex action. The now dominant portions of the brain must, I suppose, have been those the molecular states of which give rise to the "*symbols*," affection, pity, hope, and other such like "*symbols*." But experience proves that the molecular conditions of the brain indicated by these "*symbols*" are gradually developed, and cannot be called into full play on a moment's notice. It must be remembered, moreover, that the energy available for work in the blazing room was not the sum, but the difference, of two brain powers, whilst the work itself had not been rendered easier by the previous accomplishment of a similar task; and whilst volition, the note of the clock bell set ringing ever so violently, could not contribute the slightest aid. Can this be a true doctrine?

To myself, the supposed case presents no *special* difficulty. Having no doubt that some unknown power modifies the construction and grouping of the molecules in the growth of the simplest plant, I may well believe that some unknown power, possibly volition, could contribute to the setting up of the requisite molecular conditions in the brain of the man when he had to expose his body to the pain of burning in order to save his child.

It needs only to be added that, beautiful and wonderful as are the results of unconscious cerebration in animals and men, these results are not to be accounted for on the rack and pinion principle, and consequently Materialism gains not one tittle by the application to animals of the term automata; nor is it reasonable to suppose that Professor Huxley used the term in a materialistic sense, seeing he has openly avowed that he is not a materialist.

Hitherto the subject before us has been the axiom that physical theories beyond the pale of experience are derived by a process of abstraction from experience, an axiom wholly founded on the supposed perfect continuity of Nature. To which the reply has been offered that, in passing from things without life to living things, the process of abstraction is fallacious because of the discontinuity of Nature. Evolution, Natural Selection, Physiology, and Systematic Biology have been cited as affected by discrepancies seemingly incompatible with the sole sway of molecular forces.

Are there not many theories relating to inanimate things affected by apparent discrepancies? No doubt there are. It is not contended that the difficulties affecting life theories are in any degree mysterious or extraordinary; it is their appearance wherever life appears that is proposed as significant that life is not in continuity with the forces of inanimate matter.

The second part of my objection to the materialism of the *Address* needing only to be very brief will, notwithstanding the protest of Professor Huxley, be founded on a logical conclusion.

As a logical consequence, then, of potency in matter, it is true that there has been absolutely nothing initiated since the time of the falling atoms.* Some of these atoms combined and formed our world, the shape and weight of which when formed, particle by particle, must have depended on the courses, velocities and properties of the atoms. So that in the world thus formed there could be no speciality which had not had its special prefigurement in and amongst the atoms, their qualities and motions. If there was an unprefigured speciality, how did it arise? It must have been a result without an antecedent, a supposition which we must of course immediately dismiss. The world now formed accomplishes an age. A crust appears, and somewhere, on the crust, a crystal. This crystal must have had its special antecedent in the atoms. Of course, it is not meant that a certain special number of atoms in any way corresponding with those of the crystal must have been segregated. But it *is* meant that the crystal is so far traceable back, step by step, to the atoms, that a difference of a hair's breadth in the crystal must have implied a special and corresponding antecedent difference in some parts of matter and its forces throughout all previous time. If not, where did the difference begin which previously had nothing which led to it? The laws of matter and its forces are inexorably strict; their results, qualitatively and quantitatively, are mathematically

* I will not dwell on the absurdities accumulated in the suppositions—that these atoms were more *free* in their motions than the planets are now in their orbits; that they could have been falling thus from eternity; that such a state of things represents an approach to a *beginning*.

exact. The atoms could not fail to usher in the crystal, nor could they make it one iota less or greater than it came to be.

But there may have been millions of such crystals, and for every one of them, and for each of their several specialities, there must have been a corresponding antecedent; and so of all the drops and accretions, and so of every particle in the newly-formed world. But by the doctrine of potency in matter we are taught that the forces of matter are perfectly continuous, and that they are, in fact, the only antecedents and agents in life and its phenomena. To the sum of ordinary material specialities, we must then add all the thoughts of mankind and animals. Nothing but matter and its forces? Then every thought of every living sentient thing is as truly a physical event as is an earthquake, and as such must have had its special conditional antecedent throughout all previous time.

To say that the antecedents of any event become, as we recede, diffused and lost amidst innumerable cosmical changes, is high treason against materialism; it is a shifting of the ground on which materialism rests.

Let us go back to the falling atoms, and if our perception is keen enough we may discover that which has issued, and could not but issue, in what we are each of us thinking at the present moment, whilst we, together with our environments, have specialities which must issue in the thoughts of generations yet a thousand years to come. There is not now, nor ever will be, an event, a structure, or a thought more or less than special conditions were laid down for amongst the falling atoms.*

* Let it be supposed that A, B, C, &c., are atoms, an indefinite number of each of which were moving in space before a molecule of any kind was formed.

Let one A combine with one B to form a molecule A B.

Let the behaviour of A B under given environments be represented by ϕ.

Such appears to me to be the logical consequence of that materialism pure and simple which ascribes all things to the agency of forces definite and measurable. But it is by no means evident that the author of the *Address* holds a materialism of this kind, notwithstanding that some of his arguments and illustrations might fairly lead to the inference that he does. It is with these arguments and illustrations that I have dealt, to the best of my ability. For the rest, the *Address* may well be permitted to speak for itself (2nd edition, p. 53): "Lucretius cut the knot by quitting the domain of physics altogether, and causing the atoms to move together by a kind of volition. Was the instinct utterly at fault which caused Lucretius thus to swerve from his own principles?" The *Address* here treats with respect the conception of a *volition* beyond the domain of physics altogether. 2nd edition, p. 57: "The whole process of evolution is the manifestation of a Power absolutely inscrutable to the intellect of man."

The particular atom A, which should combine with the particular atom B, must have been strictly conditioned by their respective positions in space, and by the forces acting on them.

The behaviour of A B, *i.e.* ϕ, will differ from the behaviour of either A or B separately; but under every conceivable variation of ϕ under changes of environments, ϕ must be regarded as strictly conditioned by the original properties of A and B.

As to the environments, they, too, must be regarded as strictly conditioned by their antecedents.

Therefore, in ϕ, or in any possible change from ϕ to ϕ', there is no speciality which has not been brought about strictly in the way of sequence.

The case is not altered if A, B, and C, or any number of atoms combine, or when any number of molecules unite, or when the environments of the molecules are themselves the results of the inter-action of previous environments.

Therefore, under no conceivable circumstances can anything arise that is not strictly conditioned by antecedents receding through all past time.

In other words, if a thought at any moment had been one shade other than it was, that difference must have implied a corresponding difference yesterday, a thousand years ago, and in the age of the moving atoms.

No absurdity or impossibility, nor anything more than a very high degree of improbability, is involved in this conclusion, which must be simply a fact, if nothing but matter and its measurable and definable forces has existed.

The following is from Professor Tyndall's speech at Manchester:—"We are surrounded by wonders and mysteries everywhere. I have sometimes — not sometimes, but often — in the springtime watched the advance of the sprouting leaves, and of the grass, and of the flowers, and observed the general joy of opening life in nature, and I have asked myself this question: 'Can it be that there is no being or thing in nature that knows more about these things than I do? Do I in my ignorance represent the highest knowledge of these things existing in this universe?' Ladies and gentlemen, the man who puts that question fairly to himself, if he be not a shallow man, if he be a man capable of being penetrated by profound thought, will never answer the question by professing that creed of atheism which has been so lightly attributed to me."

It is evident that Professor Tyndall's creed will be far from satisfying thorough-going materialists, of whom we have at present, perhaps, scarcely a single example amongst men of science of the first class in this country, though on the continent, and amongst our own less eminent men, may be found not a few zealots in science, opposition to whose extravagances causes many to feel as if they had "got into the wrong camp."

In the present course of events, that which has really to be dreaded is not the advanced views of the leaders in science, but the intrusion of a kind of ultramontanism amongst their followers and adherents, unable to think or work except by the aid of exact prescription. But there is something above and beyond all theory, and when the glorious language of Nature is unheeded through admiration of our own skilfully constructed grammars, we are in danger of being unfaithful to Nature, and still more so to our own most necessary interests.

For Nature is a Teacher; and in the view of conflicting schools in which for many centuries almost all things have been taught except the true knowledge of ourselves and our environments, there seems not any hope for the elevation of the united human race, except through the hitherto neglected teaching of that wondrous whole of which we form a part. Nor is this opinion foreign to the wisdom of the great Instructor, Christ. If He had been listened to, if His spirit had been supremely respected, if His intense love for Nature had been observed and assimilated, we should not be discussing such rudiments in science as the principles of crude materialism, but mankind, far ahead of most of their present scientific difficulties, would now, in clearer light, be walking together at peace one with another.

But now it must sorrowfully be said that if anything there be that might urge a thoughtful mind to scepticism it is not Natural History but, in its widest sense, Ecclesiastical History. This consolation, however, remains—things always look worse than the reality when viewed historically. History of every kind is open to one great source of popular error. The earthquake, the conflagration, the interdict, the campaign find places prominent enough, but the peaceful course of human happiness and kindness is recorded only by its Author. The eclipse is chronicled, but not the blessed rising of the sun upon us every day. And what does this prove, but that calamity (needful, and beneficent in the long run though it be) is comparatively rare. He, then, who looks below the barren mountain tops, and beholds wide intervening plains and spreading regions of fertility, ought not, I think, to be assailed with charges of weak-minded optimism. I think, moreover, that if any one sees recklessness and falsity and wantonness in Nature, to such an extent that it is impossible for him to regard the whole as the work

of a beneficent Designer, this dismal and deplorable conception is not the fruit of too much, but of too little, knowledge of Nature.

Now, therefore, in the days of the first revival of a genuine love for Nature, since the era of the glorious 104th Psalm — which, though old, is as fresh as ever — I cannot but deem it an evil that the enemies of natural science should have been granted even a momentary advantage. How this has been done is truly and most eloquently told in a recent address by James Martineau, LL.D., on *Religion as Affected by Modern Materialism* (Williams and Norgate). I dare not quote from this magnificent discourse, for its language would be as a *purpureus pannus* on my own very homely style; but strongly, even earnestly, do I recommend its careful perusal.

Finally, whilst the assertion that we can know of nothing beyond matter and its forces appears to me equivalent to the entire denial of a God, in any and in every sense in which I care to acknowledge the existence of a God, it seems not less manifest that we are as yet only a very little way on the road to the understanding of matter, its properties and forces, and that the further we advance the plainer it may become that the true study of matter does not lead to Materialism.

ON THE ORIGIN AND HISTORY OF THE NUMERALS.

By JAMES A. PICTON, F.S.A.

NUMBER, Weight, Measure. The ideas presented by these terms enter so largely into our habits of life, they mix themselves up so intimately with all our pursuits, that we come to regard them as innate and instinctive; and can scarcely conceive a state of society, however rude and primitive, in which reckoning and calculation are almost, if not entirely, unknown. Closer investigation, however, will show that whatever we may think of honest Dogberry's dictum, that "reading and writing come by nature," the art of counting and calculating has only been developed by very slow and painful processes. There is, no doubt, in the human mind a latent capacity for numbers as there is for speech, but both are equally acquirements, for the origin of which we must go back to the infancy of the human race. It is not uncommon to meet with persons who, looking at the subject superficially, consider that the art of numeration is easily accounted for. We have ten fingers and ten toes. These members correspond with the digits in our decimal notation, and so the subject is at once disposed of, as deduced directly from a natural source.

Further research will very soon dissipate this superficial view. It is quite true there is a connection between our decimal system and the digits of the hands and feet, to which reference will be made in its proper place; but, antecedent to this, there is a difficult and somewhat perplexing inquiry, which carries us back into the remote vistas into which all our radical ideas have to be traced. The question

is full of interest, and one which will well reward the patient investigator.

I propose, in the following pages, to inquire how the ideas of number originated and developed themselves; how they met with vocal expression; how they became visibly recorded; what transmutations they have passed through; and to notice any interesting or curious facts connected with the history of numbers. The materials are ample, but very widely scattered. The field is so extensive as to render it impossible to embrace the whole in a short Paper like the present. I can only make such a selection as will give a general idea of the entire subject.

Whatever may be our opinions as to the origin and antiquity of man, all will admit that mentally his primitive condition bore a strong analogy to that of infancy in every generation. There was the same latent capacity of thought and speech undeveloped; the same difficulty in forming abstract conceptions; the same domination of outward sensations, at first vague and indeterminate, gradually shaping themselves into clear and definite ideas.

"The first conception which man must learn is that of his own separate independent existence; and without the conscious distinction between himself and his surroundings he could not advance a single step." *

"The baby new to earth and sky,
  What time his tender palm is prest
  Against the circle of the breast,
Has never thought that this is I.

But as he grows he gathers much,
  And learns the use of 'I' and 'me,'
  And finds I am not what I see,
And other than the things I touch." †

* See Farrar, *Chapters on Language*, p. 62.

† *In Memoriam*, sec. 44.

The perception of the difference between the *ego* and *non-ego* would lead to an expression, monosyllabic, no doubt, for the concrete ideas of "*I*," or "*me*," and "*thou*." From duality, the transition to an expression for plurality would be short and easy, and there the mind might rest. History, etymology, analogy, and observation, all combine to show that for untold ages the human race had proceeded no further than this in the art of numeration. Even at the present day there are many races which have not advanced beyond this stage.

The Brazilian Indians can only count up to three; any number beyond this they express by the word "many."* The aborigines of New South Wales possess no numerals beyond—

1 Wagul,
2 Boola,
3 Brewy.

When a number exceeds three they use the phrase *murray-loolo*, which signifies an indefinite number.† Aristotle mentions a certain tribe of Thrace whose numeration was limited to four.

Many tribes have been found who cannot count beyond five; but in most if not all these cases, although their arithmetic is not expressed in words, they have signs which in various ways, without vocal expression, carry their numeration to a much greater extent.

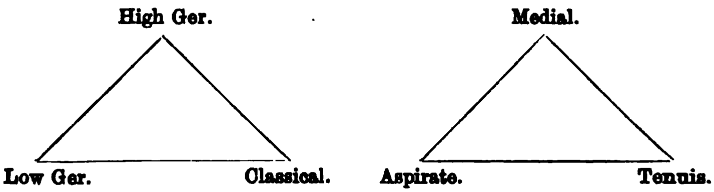
In the early stage to which I am now referring, numerals, meaning the abstract ideas of number, could hardly be said to exist. One, two, and three were rather demonstratives of something concrete and definite before the eyes.

It has been the opinion of some of our most distinguished philologists, that in the Aryan or Indo-European

* Balbi, *Atlas Ethnogr.*, p. 289.
† Collins's *New South Wales*, App.

languages the first three numerals are identical with the three personal pronouns.* The arguments for this conclusion are too subtle and lengthy to be reproduced here. In regard to the two first, the evidence appears very strong, but the identification of the numeral "three" with the pronoun of the third person seems to me to be founded on a false analogy. There is, however, a relation between the numeral *two* and the pronoun of the second person, which I have not found hitherto noticed, but which is too curious to be passed over.

Every student of philology is acquainted with the rule of phonetic change in the Aryan tongues, called Grimm's law, by which particular consonants in each of the three leading dialects are uniformly represented in the others by equivalents of a different class. The arrangement is tripartite, thus—



Taking the order from right to left, we find a tenuis or hard consonant in Greek and Latin is represented by an aspirate in English and Low German, and by a medial or soft consonant in High German. Thus *tres* in Latin becomes *three* in English, and *drei* in High German. In like manner the aspirate in Latin becomes a medial in English, and a tenuis in High German. Latin *frater*, Sanskrit *bhratar*, English *brother*, Old High German *pruodar*. In this case the rule is exemplified both in the initial and middle consonants. Applying this to the pro-

* See Professor Pott, *Die Quinare und vigesimale Zählmethode*, p. 149; also Dr. Donaldson's *New Cratylus*, p. 280.

nouns and numerals, Latin *tu* becomes in English *thou*, and in High German *du*. Latin *du-o* has for its equivalent in English *two*, in High German *zwei*.* Now the phenomenon to which I wish to draw attention, is the fact that the relation between the dual numeral and the pronoun of the second person in each language, is the same as that between the numerals themselves and the pronouns themselves in the passage from one language to another. Thus *duo* in Latin has the same phonetic relation to the pronoun *tu* as it has to the English numeral *two*. The English *two* finds its aspirated representative in the pronoun *thou*, and in the High German *zwei*; whilst the High German aspirate takes the medial sound in the pronoun *du*, and in the Latin numeral *du-o*. It would be contrary to all analogy to suppose that this systematic phonetic relation is fortuitous. It indicates a close connection between the personal pronouns and the rudimentary numerals.

The limited conception of numbers in the infancy of the human race is further illustrated by the existence of the dual number. *A priori* it is difficult to see why separate inflexions should be applied to the number two, rather than to five or seven, or any other numeral; but if we conceive a condition of mind in which the only idea of numbers is contained in the three notions of individuality, diversity, and plurality, the reason for dual inflexions is at once obvious. Each conception would require its own expression, and thus the three sets of inflexions would grow up. Almost all languages, in their early stages, have possessed a dual number, which has gradually dropped out of use as the necessity for it ceased.†

* *Z* in High German answers to the aspirate *th* in English.

† Even in our own mother tongue, the remains of a dual number are found, in the obsolete pronouns *wit*, we two, *gyt*, you two, with their inflexions *uncer*, *uncrum*, *incer*, *incrum*.

These considerations all tend to confirm the inference derived from observation, that for many ages the art of counting was limited to the clear conception of *one* and *two*, with a vague notion of plurality for all beyond. The numeral *three* itself presents strong evidence of this. Its root is found in Sanskrit तृ, *trí*, to pass beyond, to exceed, and its derivations in all the affiliated tongues will be found to include the same idea. Thus, Sanskrit, *tiras*, across; *tira*, the opposite shore. Greek, τέρας, a monster, that which exceeds nature; τέρεω, to bore through, to pierce; τέρθρον, the end, extremity. Latin, *trans*, across, beyond; *terebro*, to pierce through. So the various compounds with *tra* and *trans*, *ex-tra*, *in-tra*, *trans-eo*, *trans-gredior*, etc. We find the radical with the same sense of excess in French, *trés*, *tróp*; in Italian, *troppo*, *trapasso*, etc. In English, besides the numeral three, we have *tres-pass*, *through*, *troop*, etc. Instances might be multiplied from all the Aryan family.

How long the early human race continued circumscribed in their notions of number within the narrow circle thus traced out, it is impossible to say; very probably, during untold ages. The emergence to a wider sphere in which abstract ideas of number began to prevail was accomplished partly by the use of metaphor and figure, and partly by building up, one after another, the successive numerals as they were required.

The tribe of Indians called Abipones, in passing out of the rudimentary ideas of the first three numerals, call the fourth *geyenknate*, which signifies "emu-foot," the emu having four toes on each foot, three before, and one turned back. Number five is *neentalek*, the name of a skin having five colours.*

Time and space would fail to go at length into all the

* Dobrizhoffer, *History of the Abipones*.

expedients adopted for giving expression to the scale of numbers as they developed themselves. Sometimes a particular phrase was applied to special objects, and limited to those alone, of which we have some relics in our own language, as a *pair* of horses, a *couple* of dogs, a *brace* of partridges.

In the Aryan tongues, the development took the form of additions to the existing numerals. The connexion can be traced through the whole family of languages, but I give the Sanskrit as probably approaching more nearly the original radicals. *Chatṛi*, or *chatur*, four, there can be little doubt, was originally *eka-cha-tṛi*, one and three, the *eka* being dropped, and the word abbreviated to *chatur*, Latin *quatuor*. At the numeral five we enter on a new development. All nations, almost without exception, which have attained the art of counting up to five, have adopted the quinary and decimal notation, arising naturally from the fingers and toes, five on each member, twenty in the whole. Still it was only by slow degrees that the decimal system of numerals was attained. When the number five was once reached, it became naturally identified with the outstretched hand. Thus *panchan*, the Sanskrit numeral for five, is connected with *páṇi*,* the hand, but is really derived from *panch*, to stretch out, to extend. In many languages, the quinary system was adopted, the numbers recommencing after five. Thus, in New Caledonia, Pānim is the word for five.

6 Pánim-gha.
7 Pánim-roo.
8 Pánim-ghen.
9 Pánim-bai.
10 Párooneek.

* *Páṇi*, the outstretched hand, is doubtless connected with *panch*. The hand, as a prehensile instrument, is *hastah*. Thus one name for the elephant is *hasti*, the animal with the hand.

Amongst some of the central tribes of Africa the same system is adopted. In the language of the Jaloffs, as given by Mungo Park, *juorom*, which signifies the hand, is the numeral five.

6 Juorom ben.
7 Juorom niar.
8 Juorom nyet.
9 Juorom nianet.
10 Fook.

The modern slang of the ring, in which the hand is called "a bunch of fives," is an unconscious reversion to the primitive origin of the numeral.

The Jaloff system is a very perfect example of the quinary mode of computation.

11 Fook agh ben.
12 Fook agh niar, etc.
15 Fook agh juorom.
16 Fook agh juorom ben, etc.

The Aryan races did not adopt the quinary system, but continued to build up the series of numerals until they reached ten. In these there are not apparent any figurative or metaphorical references, such as are found in some of the Eastern languages. They are simply accretions, or reduplications of the previously existing numbers. *Six*, Sanskrit *shash*, is supposed to be a doubling of three, *cha-tri-cha-tri*, the tri having fallen out for euphony's sake. *Seven*, Sanskrit *saptan*, is by some identified with the Semitic numeral. It presents a problem not very easy of solution. *Eight*, in all the Aryan tongues, had originally the dual termination; Sanskrit, *ashtau*; Greek, οκτω; Latin, *octo*; Gothic, *ahtau*.

This leads to the impression that it was originally a reduplication of four, *chatur-au*.

The root of *nine*, in all the kindred languages of which we are speaking, seems to have a close connexion with the radical of *new*. Sanskrit, *navan*, nine; *navah*, new. Latin, *novem*, *novum*; Greek, *ἐννέα*, *νέος*; German, *neun*, *neu*; Gothic, *niun*, *niujis*. Being the latest formed of the digits, this radical meaning seems sufficiently appropriate.

After many ages of gradual and painful labour, the decimal principle was at length arrived at, which gave a new impulse and starting point to arithmetical notation. That this principle owes its origin to the fact that we have ten fingers on the two hands, there can be no doubt whatever. Every nation which has reached the art of counting ten has adopted it. In the derivation of the numeral *ten*, we find considerable assistance from Grimm's law of phonetic change already alluded to. Sanskrit *das'an*, Greek *δέκα*, Latin *decem*, answer to Gothic *tehund*, A. S. *tyn*, High German *zehn*. These can be traced in each language to roots signifying to point, to indicate; Sanskrit *dis*, Latin *dic*, Greek *deik*, High German *zeh-on*, Low German *teik-an*. From the same root are derived Greek *δάκτῦλος*, Latin *dig-itus*, German *zeh-e*, A. S. *tah*. These signified at first both fingers and toes, but in the course of time they have become apportioned, some to one, some to the other. The finger, then, is that which points or indicates. From the number of fingers being ten, the word was appropriately enough employed to indicate the completion of the series. Another theory of the origin of *decem* and *ten* has been put forward by Lepsius,* that *decem* and its equivalents signify the duplicate of five.

Up to this point all the Aryan languages agree. The

* *Zwei Sprachvergleichende Abhandlungen*, Berlin, 1836.

first ten numerals are radically alike in all, which furnishes strong evidence that these numerals had been adopted previous to the separation of the race into distinct nations. From this the course of the numerals follows a somewhat different, though parallel, direction in each language. The classical tongues form the second decimal series by the suffix of *decem* to the first, *undecem, duodecem, tredecem,* &c. The Germans, both high and low, form the two first in a different way, Gothic *ainlif, tvalif,* Old German *einlif, zwelif,* A. S. *endlufon, twelf.* The same form prevails in the Lithunanian *wenolika, dwilika.* The meaning, in both cases, is that of *one left, two left* beyond ten. In the Lappish it takes the form of *akta lokke naln,* "one upon ten."† Here the mode of expression stops, and the higher numerals follow the classical mode. To these indications of a duodecimal scale I shall have occasion again to refer.

The Welsh language follows the classical as far as fifteen, *pym-theg* (pump-deg, 5 and 10), and then proceeds by a fresh series.

16 unarpymtheg (one over fifteen).
17 dauarpymtheg.
18 triarpymtheg.
19 pedwararpymtheg.

This is an instance of the quinary system, or reckoning by fives, which retained its place notwithstanding the decimal scale subsequently adopted.

Twenty is represented by Sanskrit *vins'ati,* Greek εἴκοσι, (Doric εἴκᾰτι), Latin *viginti,* Gothic *tvaitigjus,* A. S. *tweontig,* High German *zwanzig,* Cymric *ugaint.* However diverse these may at first sight appear, they are all reducible to

† See Wedgwood, *Dict. Eng. Etymology,* ii. 7.

expressions for twice ten, and so the decimal scale thus established proceeds by tens to hundreds.

At this early period in the progress of civilisation, we must not look for logical accuracy in the formation of expressions for new ideas as they arose. We must expect much of a make-shift character, many anomalies which gradually settled down into definite established words. In the decimal numeration, it is agreed by nearly all who have written on the subject that the radical in the numeral *ten*, and its multiples up to a hundred, is identical, however disguised and changed it may appear. In Latin, the *cem* in *decem*, *gint* in *viginti*, *cent* in *centum;* in Teutonic, the *hun* in *tai-hun* (ten), *hund* for a hundred; in Celtic, *gaint* in *u-gaint* (twenty), and *cant* (a hundred), are believed to be all branches from the same stem. Their adaptation varied with circumstances, and was naturally productive of some anomalies.

In the decimal stages, from twenty to a hundred, there are three elements; the prefixed numerals two, three, &c., the equivalent for ten—*gint*, *gaint*, &c., and the suffix *ta*, *ty*, *tig*. These elements are employed in different proportions in the several Aryan tongues, and in some of them in rather a capricious manner. The Latin and Greek are the most regular, proceeding systematically from triginta (tri-gint-ta), and τριάκοντα, through the entire scale. The Sanskrit, in which we might *a priori* have expected the most regularity, is abnormal.

20 vins′ati.
30 trins′at.
40 chaturins′at.
50 panchas′at.

The *s′at* in these numerals represents the *san* in *das′an*, *n* being frequently thrown out in similar cases. From 50 upwards, *sat* is rejected.

60 shash-ti.
70 saptati.
80 as'íti.
90 navati.

The *ti* is doubtless the equivalent of *tig*, *ta*, *ty* in the cognate tongues.

In the Teutonic family, which is represented in its most primitive form by the Gothic language, the opposite course is adopted. The radical *ten* is rejected in the earlier part of the series.

20 tvai-tigjus.
30 threis-tigjus.
40 fidvor-tigjus.
50 fimf-tigjus.
60 saihs-tigjus.

From this point, *tig* or tigjus is exchanged for *hund*—

70 sibun-tehund.
80 ahtau-tehund.
90 niun-tehund.

The most probable explanation of these anomalies appears to be the following. The radical, which is the basis of *hund*, *gaint*, *cem*, *gint*, originally signified *ten*, but beside this there grew up an expression, tig, ta, &c., implying a series, as in the Latin *plex*, in *duplex*, *triplex*, and English *fold*, *threefold*, *fourfold*, &c. As ten was the usual series, the two expressions would become interchangeable, sometimes adopted together, and at other times the one substituted for the other. Thus, as *hund-seofon-tig* is literally ten-seven-times.

In the old Norse, represented by the Icelandic, which is the mother of the Scandinavian languages, and very closely

allied to the Gothic and to our own tongue, the suffix *ti* or *tiu* in the higher numbers, has superseded the original *tan* or *ten*, which is, however, retained in the lower series.

13 thret-tán.
14 fje[illegible]án.
15 fimmtán, &c.

Anomalies of a different kind are found in the Celtic tongues, to which I shall have by-and-bye to allude.

Divers theories have been propounded for the origin of the word *hundred*. Mr. Wedgwood* derives it from *hund* and *rad*, ratio, reckoning, number. The word is of comparatively late date in Anglo Saxon, and is apparently of Danish introduction. The original form in Low German is *hund*.

Horne Tooke,† following Wachter,‡ takes the hand as the source of all numeration, and supposes that *hund* and *hand* are synonymous, a *hundred* being the hands ten times closed. The learned Lepsius adopts an idea very similar, which is referred to by Dr. Donaldson.§ It seems, however, very far fetched and unsatisfactory. The real explanation lies much nearer the surface, and was hinted at, though not fully carried out, by Francis Junius.‖ In the Gothic language, the representative of the Low German tongues, we see the formation under our eyes. *Taihun* is ten; *taihun-taihund*, or ten-tens, is one hundred. The same radical being used for the numeral ten and its various multiples, an abbreviation naturally took place, and *taihun-tehund* became contracted into *hund*. In other languages, by the operation of causes probably connected with Grimm's law of phonetic change, with an alteration of meaning, the initial consonant

* *Eng. Etymology*, ii. 268. † *Diversions of Purley*, *sub voc.*
‡ *Gloss. Germ.*, *sub voc.* § *New Cratylus*, p. 296.
‖ *Etymologicum Anglicanum.*

was changed. Latin *gint* became *cent*, and Cymric *gaint* become *cant*. In this way, what was at first a somewhat confused application of a single root gradually took the distinctive form in which it has come down to us.

In the numbers above a hundred, the languages widely diverge. Greek χίλιοι signifies an indefinite large number, χιλός, a heap, from χέω, to pour out. Latin *mille*, of which the derivation is unknown, indicated the same meaning; *miles*, a soldier, one belonging to a large organised body.

The Sanskrit word for thousand, *sahasra*, is from a root signifying strength, power. The origin of the Teutonic *thousand* is obscure. It has been attempted to derive it from *tiguns-hund*, ten hundred; but this explanation is far from satisfactory. The most probable source is from an old root, *thysja*, *thusa*, to swarm, to abound. The early use of the word was not for a definite number, but as a vague term denoting a swarm, crowd, multitude. So the Hebrew word for thousand, *eleph*, signifies properly a herd of oxen. The Celtic tongues have drawn their words for thousand, *mile*, *mila*, from the Latin.

Million is a word of comparatively modern introduction. Greek μυρίος signified an indefinite countless number, but μυρίας was afterwards employed in the sense of ten thousand. Thus, in the Apocalypse ix. 16, δισμυριάδες μυριάδων, two myriads of myriads, is 20,000 × 10,000, or two hundred millions. The word *million* only occurs once in our authorised version of the Scriptures, Gen. xxiv. 60: "Be thou the mother of thousands of millions." The original is *lealphey rebabah*, "for thousands ten thousand," or a thousand times ten thousand. *Millione* is the Italian augmentative of *millia*, meaning the greater thousand.

I have thus sketched a brief outline of the progress of

early notation, generally, and in its development into the decimal system with especial reference to the Aryan family of tongues. I will now proceed to notice some peculiarities in the various numeral systems which present themselves to our view.

That the decimal scale originated from the ten fingers and ten toes of the human race, there can be no question. Had we been blessed with six digits on each member, the whole system of numeration would have been changed, and in many respects for the better. Ten is a very impracticable number. It is only divisible by two and five, whilst twelve is divisible by two, three, four, six, and partially by eight. Our early Teutonic and Scandinavian forefathers had a great predilection for the number twelve. Although finally adopting the decimal scale, there is a pause in the ascending numbers at twelve, indicating a separate and distinct formation, which it appears was not abandoned without regret, and which has left very distinct marks in our mode of counting.

There is no method of counting time more common amongst early nations, than by moons or months; indeed, the day and the month are the only periods of time determined by the phenomena of nature. Amongst the early Greeks, twelve was a standard number, and it has been suggested * that the Ionian word for a month employed by Homer, μείς, is connected with the feminine form of the unit μία.

Twelve was the fundamental number of the Ionians; they had twelve principal towns. The Greeks had twelve greater gods, most of them connected with the months, and in the political subdivisions, twelve is a prevalent number. Our day and night are divided into twelve hours each. Amongst the Hebrews twelve was a very distinguished number, and

* Donaldson, *New Cratylus*, p. 281.

occurs very frequently in the Scriptures. There are twelve princes of Ishmael; twelve sons of Jacob; twelve tribes of Israel; twelve precious stones in the high priest's breast-plate. Our Lord called twelve Apostles. In the Apocalypse, twelve and its multiples are the most prominent numbers. The heavenly city had twelve gates, twelve foundations; its walls measured on each side twelve times twelve cubits. The tree of life bare twelve manner of fruits. The number of the sealed out of each of the tribes of Israel was twelve times twelve thousand.

Amongst the early Teutons and Scandinavians, the word *hundred* signified 120, or 12 times 10. The decimal hundred was expressed by Norse *tin-tin*, Gothic *taihun-tehund*. With the conversion to Christianity, the decimal hundred was introduced by the Church, but the two have run side by side down to the present time in Iceland, under the names of *tólfrœt hundrath* for the duodecimal, and *tírœtt hundrath* for the decimal scale. The Icelandic farmer counts his flocks, and the fisherman his takings, by the duodecimal scale. Even amongst ourselves, the long or duodecimal hundred of 120 has lingered in many transactions, both of weight and measure. The dozen, and its square, the gross (144), constitute the measure by which many important articles are distributed to the public. There are 12 inches lineal and 144 square inches to the foot; and in the calculation of areas and artificers' work, the duodecimal mode of computation still maintains its position.

At Clovelly, and at other places on the north coast of Devon, the mode of counting adopted by the fishermen is a relic of the primitive system. Three fish are thrown at once, and called a "cast." Forty casts make a long hundred (120). Ten more casts are counted, making in all 150. The fisherman then adds another cast of three, making the whole number 153, the quantity of the miraculous draught

of fishes in the Sea of Galilee. This process repeated four times makes 612, which is called a *meas* or *maze*, by which measure the fish are sold.

It is singular that the mode of counting herrings in the Isle of Man, separated by such a long distance, is almost identical with that just described. Each cast of three is called a *warp*; 40 warps make a tally or duodecimal hundred, five tallies with three thrown in to each tally and four at the close make the *meas*; 620 against 612 in the former case.

I have already alluded to the quinary system of reckoning by fives on the fingers of one hand, which undoubtedly constituted the first stage in any systematic method of counting. In most languages it has been superseded by the decimal scale, but it has in many cases left evident traces of its influence.

In the Latin system of notation, a new series of symbols commences with 5, 50, and 500. The Greek word for counting, πεμπάζω, literally to *five*, or number by fives, is a curious relic of this primitive time. So we read in the *Odyssey*, when Proteus is described as about to count his marine stock—

> his herd
> Of Phocæ numbering first, he will pass through,
> And sum them all by *fives*.
>
> *Od.* iv. 412.

The Cymric or Welsh is almost the only existing Aryan language which retains the impress of the quinary system. The kindred Celtic tongues, the Gaelic, &c., have adopted the decimal system throughout.

The creation of numeral scales in modern days is curious, and may throw some light on the similar process in primitive times.

In the purlieus frequented by the Italian organ-grinders in London, a peculiar jargon of Anglicised Italian has sprung

up, in which a scale of numeration is found, based upon sixpence as an integer, divided into six *soldi*, Anglicised into *saltee*, which runs as follows—*

1 Oney (uno)
2 Dooe (due)
3 Tray (tre)
4 Quarterer (quattro)
5 Chinker (cinque)
6 Say (sei);

for anything beyond sixpence the scale begins again—

7 Say oney saltee.
8 Say dooe saltee, &c.

This is the only instance of a sexary scale which has come under my notice.

In the Yorkshire dales, a mode of scoring sheep exists, the scale of which, though different in nomenclature, is identical in principle with the Cymric.

1 Yaan.
2 Taihn.
3 Tedhurn.
4 Edhurn.
5 Pimp.
6 Saajis.
7 Laajis.
8 Saova.
9 Daova.
10 Dik
11 Yaan aboon (one above).
12 Tain aboon.
13 Tedhur aboon.
14 Edhur aboon.

* *Macmillan's Magazine*, April, 1874, Article by Mr. Tylor.

Here the scale recommences—

15 Jigit.
16 Yaan ugeeh'n (one again).
17 Tain ugeeh'n
18 Tedhur ugeeh'n.
19 Medhur ugeeh'n.
20 Gin ugeeh'n.*

From numeration by fives and tens, the fingers of one and two hands respectively, we might naturally expect that the combined number of all the digits, twenty, would occupy a prominent position in early scales. The most remarkable vigesimal scale of numeration is that of the Mexicans. The decimal scale is adopted as far as twenty; that is to say, after ten the primitive digits are repeated, but from twenty onwards the numbers are taken by twenties. Thus 34 is *canlahutukal*, literally fourteen and twenty. After 40, each number is expressed as belonging to the score in which it stands; thus 61 is *huntucankal*, or the first of the fourth score.

This mode of counting by twenties had a practical influence. In the army, twenty men constituted a squad or company. Twenty twenties, or 400, formed a battalion, and twenty battalions formed a corps or army. A load of any articles was reckoned by twenties.†

The Celtic languages bear, at the present day, unmistakeable reminiscences of the vigesimal method of numeration. From twenty onwards, instead of reckoning by tens, the Welsh is as follows:—

20 Ugain.
30 Deg ar ugain (ten and twenty).
36 Un-ar-pymtheg-ar-ugain (one and fifteen and twenty).

* A. J. Ellis, *Tran. Philog. Socy.*, 1870, p. 117.
† Pott *Zählmethode*, p. 99.

40 Deu-gain (two twenties).
80 Pedwar ugain (four twenties).
90 Deg-ar-pedwar ugain (ten and four twenties).

Here we see at once the source from whence the French language derives its uncouth and clumsy circumlocutions :—

80 Quatre vingt.
90 Quatre vingt dix, etc.-

They have no doubt been introduced from the Celtic element in the French nationality.

Reckoning by twenties has also been prevalent from the earliest period amongst the Low German and Scandinavian races. Our word *score* is of Northern origin, though closely allied to the A. S. *scyrian,* to shear or cut. Anciently, a score stick was used in keeping accounts. Notches were made on both edges, representing the numbers up to twenty. The stick was then slit or divided, each party retaining one half, so that the notches could not be altered without the knowledge of both. The stick so divided was called a *tally* (Fr. taillée), and was evidence in case of need. Thus Chaucer :—

"Ye have mo slakke dettours than am I,
For I wol pay you wel and redily
Fro day to day, and if so be I faille,
I am your wif, *score* it upon my *taile*" (tally).

Shipmanne's Tale, 13, 344.

Jack Cade accuses Lord Say: "Whereas before, our forefathers had no other books but the *score* and the *tally,* thou hast caused printing to be used" (*2nd Henry VI.,* act iv., scene 7). *Score* thus became synonymous with twenty, and is very freely used by our old writers in preference to the decimal expression. It often occurs in our authorised version of the Scriptures.

"The days of our years are *three score* years and ten,

and if by reason of strength they be *four score* years, yet is their strength labour and sorrow."

The scale of sixty, which is employed for astronomical and chronological purposes, was, it is believed, derived from the Chaldeans. Sixty seconds make a minute, sixty minutes an hour; sixty miles are a geographical degree; six times sixty are the degrees of the circle.

I have so far endeavoured to trace in a succinct and general way the origin and progress of our decimal numeration. The subject might be pursued at much greater length, but little would be gained in its illustration by the multiplication of specimens, of which any number may be obtained from all the languages of the earth. There is a remarkable similarity in the mode of working out the decimal system of notation, which is a strong proof of the identity of the faculties of the mind in all the races of the world.

I propose now to call attention to the origin and growth of the visible symbols which have been employed from the earliest ages. The art of counting no doubt existed, at least in a limited degree, untold ages before any attempt was made to embody it in legible signs.

The simplest and most natural symbol would be a stroke or a dot for each unit. The Mexicans, who never advanced in writing beyond hieroglyphics, expressed their vigesimal system of notation by a dot for each unit as far as twenty, which was designated by a banner , indicative of a military squad of twenty. Twenty times twenty, or four hundred, was indicated by a feather , the sign of command of a troop of that number. Twenty times four hundred, or eight thousand, was represented by a figure of a purse or sack, supposed to contain that number of grains.

In the Egyptian hieroglyphics decimal notation is fully

carried out; the units are represented by strokes, tens by a horseshoe form ∩, hundreds by a symbol almost similar to our cursive 9 . Forty-two would be expressed thus 

These methods of notation preceded alphabetical writing. It was natural when an alphabet was once adopted that the letters should be employed to indicate numbers. The Hebrews, as is proved by the evidence of coins, employed the letters of the alphabet in this way at least as far back as the time of the Maccabees, about 150 years A.C., and probably much earlier. All the existing MSS of the Old Testament have the numbers expressed in words at length; yet, from the variations in the several versions between themselves and from the Hebrew text, it seems more than probable that some abbreviated form had been earlier in use, which gave rise to the errors and variations. In Hebrew, the first nine digits are expressed by the letters of the alphabet, from Aleph (א) to Tet (ט). The tens, from 10 to 100, are represented by the succeeding letters, from Yod (י) to Kof (ק). The hundreds, from 200 to 400, have the letters Resh (ר) to Tau (ת). The higher numbers are formed by the composition of letters, the smaller numbers going first.

The Greeks had two methods of notation. According to the earliest mode the numerals up to 4 were expressed by strokes I, II, III, IIII. Π, the initial of πεντε, stood for 5; ΠΙ = 6, with additional units up to nine. Δ, the initial of δεκα, stood for 10. Units were added up to 19. A double Δ Δ represented 20, repeated in each decade up to 40. Δ within Π, 𐅄, or 5 times 10, stood for 50. Additional Δs were added up to 90. 100 was represented by H, repeated up to 400. 500 had the character 𐅅, 100 enclosed within 5. X, the initial of χίλιοι, stood for 1000, repeated up to 4000. For 10,000, or a myriad, the initial M, of μύριοι, was adopted.

This method was exceedingly cumbrous. For instance, 9999 would be thus represented :—

𐅇XXXX 𐅅HHHH 𐅄ΔΔΔΔΠ IIII

A mode was therefore adopted of applying the letters of the alphabet in three groups of nine each, the first representing the units, the second the tens, and the third the hundreds. As, however, the Greek alphabet had only twenty-four letters, they were obliged to eke out the number by adding for 6 the sign for *st*, ϛ′, called *ἐπισημον*; another sign ϟ, called *κόππα*, for 90; and a third, called *σὰν πῖ*, ϡ for 900.

When letters were employed for numbers they had an acute accent attached. To express thousands the mark was placed underneath. Thus, 9999, in this improved mode of notation, would be written thus, ͵θ ϡϟ θ′. This system was still very imperfect when compared with the modern method of giving the numbers power by position, as in the so-called Arabian numerals; but the Greek philosophers, in working out their problems in the higher mathematics, carried out by special signs the expression of numbers to an almost illimitable extent. In a Paper like this it would be out of place to pursue the subject further.

Amongst the Teutonic nations, the Goths, when in the fourth century A.D. they formed an alphabet for themselves, adopted the Greek system of notation, adapted to their own alphabet up to 1000. As twenty-seven characters were required, and they had only twenty-five letters, two additional characters were imported. 𐍁 for 90, and 𐍊 900. In the Gothic remains we have no numerical characters for the higher numbers.

The other Teutonic and Scandinavian nations, in their early stages, expressed their numerals by the Runic letters, thus: —

ᚠ Fé ... 1

ᚢ	Ur	...	2
ᚦ	Thorn	..	3
ᚬ	Os	...	4
ᚱ	Reid	...	5
ᚴ	Kaum	...	6
ᚼ	Hagl	...	7
ᚾ	Naud	...	8
ᛁ	Is	...	9
ᛅ	Ar	...	10

As they possessed only 16 letters, in order to note up to 19, they had to invent three new characters. This they did by combining two letters, thus :

ᛮ	Arlaugr, a combination of A and L	...	17
ᛯ	Tvimadr, mm	...	18
ᛰ	Belgthor tt	...	19

Twenty was expressed by doubling the ten. The higher numbers were expressed by combining the lower ones.

When the Norsemen and the German nations embraced Christianity, they adopted the Latin method of notation, which was also the case with the various members of the Celtic family. We have no numerals of pre-Roman character from this latter source.

I will not weary my readers by further extended observations on the various methods prevalent for presenting to the eye symbolical characters for the numerical scale. With the exceptions about to be noticed, they are all either adaptations of alphabetical letters, or arbitrary signs, each having its own value independent of position. Before bringing under notice the systems adopted in modern times, let us glance for a moment at the arithmetical forms of the oldest existing civilisation, the Chinese.

The Chinese written language, as is well known, is one

of symbols, which, pronounced differently in the different dialects, present the same ideas to the reader. It is therefore eminently adapted for numerical notation, which in Chinese is probably as perfect as any system can be which lacks the power of value by position. The Chinese have three modes of notation. One, the historical and literary, containing, no doubt, the original forms; the second, a set of figures more complicated, used for formal documents, probably to prevent forgery; the third is in a cursive style, adapted for rapid writing in mercantile transactions.

In each series there are seventeen signs, by the combination of which every number may be readily expressed. The second or formal series are characters to which other meanings are attached. Thus, the sign for one means *perfection;* that for two, to *separate;* for three, an *accusation;* and so forth. The application of these characters as numerals may be merely conventional, employing them mnemonically to aid the memory; or, there may be some hidden mystic meaning implied which does not at first sight appear. The first or historic series seems to have developed itself naturally, and to have descended from a very early period. The characters and names in this series have no other meaning. The figures are as follow :—

一 yĕ, 1.
二 ûrh, 2.
三 sān, 3.
四 see, 4.
五 woo, 5.
六 lo, 6.
七 tsĕ, 7.
八 pā, 8.
九 chew, 9.
十 shĕ, 10.

There are other characters respectively for

100, pĕ.
1,000, yĕ-tseen.
10,000, yĕ-wan.
100,000, shĕ-wan.
1,000,000, pĕ-wān.

By the combination of these figures any number can be expressed. They are written vertically; thus for twenty-two we have

二 urh—two.
十 shê—tens.
二 urh—two.

The Chinese, in arithmetic as in many other arts, have approached very near the solution of a problem, but have just missed it. There is a character called *ling*, which is used like our cipher 0 to express zero. By its means, 1,001 would be thus expressed:—

千	yĕ tseen	1
零	ling	0
零	ling	0
一	yĕ	1

This is certainly a very close approximation to the Indian or Arabic system, but useless, on account of the figure for 1,000 being clogged with the sign *tseen*. If that were omitted, the value of the figures increasing geometrically by position would be complete.

We now approach the system of notation which for at least a thousand years constituted the basis of numeration amongst nearly all the civilised nations of Europe—the Latin or Roman method. That the Greek and Latin alphabets were originally derived from the Phœnician is generally

admitted. It is also evident, on examination, that the early systems of notation in Europe were principally based upon the use of alphabetical characters, supplemented by arbitrary signs. The Greeks subsequently adopted a simpler method, as explained above, but the Romans continued to the end their employment of the original signs. The germ of these and their development to a considerable extent is found in the Phœnician inscriptions, particularly as exhibited in those at Palmyra, as follow.

The first four numerals are simple strokes :—

5	>
6	I>

Strokes are added up to 9.

10	ƛ

with added strokes to 14.

20	Ↄ

with added strokes to 24.

25	> Ↄ
30	ƛ Ↄ
100	ƛ I
1000	$\overline{\text{ƛ ƛ I}}$

We have here a great resemblance to the Roman system. The sign for five is the same, though placed sideways > instead of upright V.

The Roman 10 = X is an improvement on the Palmyrene ƛ, and really is a combination of two fives.

The signs from 20 upwards diverge, but the principles and combinations are very similar.

The sign for 50 is supposed to have been the Greek ψ, written cursively ⊥, and abbreviated into ∟. C for 100 is usually considered as the initial of centum, but others maintain that it is derived from the Greek Θ. The sign for 1000

was originally CIↃ, supposed to be the Greek dental aspirate. The half of this, IↃ, stood for 500. The two latter, from their resemblances, were modified into M and D. A stroke over the letters indicates thousands.

There were other forms in use, of a more arbitrary character, such as ∞ and T for 1,000, ✦ for 10,000, etc.

It will be seen that the Romans had only seven distinct signs to express all their numerical quantities, I, V, X, L, C, Ḋ, M. The intermediate numbers were expressed by the repetition of these signs. Necessity, however, or convenience, led to some modification. In order to avoid the iteration of the units and tens, they were placed in certain cases on the left of the superior number, to indicate subtraction. Thus for 4, instead of writing IIII, a unit was placed on the left of five, to indicate one less, IV. So also with IX, XIX, XL, XC. This was the first step in giving value to figures by their position, which afterwards led to such important results.

Another move in the same direction consisted in placing the numerals for thousands on the left of the hundreds, with a point between. This, with the addition of the bar, also indicating thousands, aided in giving expression to very large numbers, as in the following example:—

$$\overline{\mathrm{XVI}},\mathrm{DCLXVI.DCLXVI}\ (16{,}666{,}666).$$

The numeral notation of the Romans was adopted in almost every part of their extensive empire, and the influence of Latin Christianity carried it beyond the Imperial domains amongst the Teutonic and Celtic nations, where it superseded their primitive notation, and reigned undisputed, until in modern times it has been practically, though not entirely, abrogated by a more perfect system.

Accustomed as we are to the ready method of arithmetical computation effected by the use of the Hindoo or

Arabic numerals, entering into almost every transaction of our daily lives, it is difficult to imagine a state of things in which this system was entirely unknown. The cumbrous nature of the Roman numerals precluded their use in calculation, but the deficiency was supplied by a contrivance called the *abacus*, the origin of which dates from a very high antiquity, its invention being ascribed to Pythagoras, more than five centuries before the Christian era. It is probable, however, that its invention is of much older date, as it has been in use in China, under the name of the *swan-pan*, from a period far beyond the range of history. Amongst the Romans, it formed the ordinary method of reckoning, under the name of *abacus* or *tabula*. These terms are often referred to by the classical authors. Horace describes a boy marching to school with his tabula suspended from his left shoulder :—

> "Quo pueri magnis ex centurionibus orti,
> Lœvo suspensi loculos *tabulam*que lacerto."*
>
> *Sat.* i., vi., 75.

The abaci differed slightly in their construction, but the principle in all was the same. I will endeavour shortly to give an illustration of it.

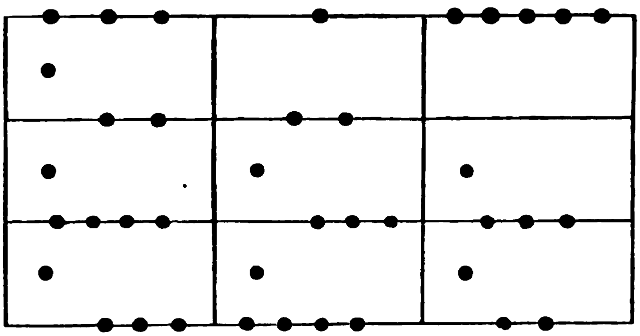
The abacus taken to school by the young Calpurnius Piso, or Julius Cœcina, was a flat rectangular board, something like the modern school slate. When not intended to be removed it was strewed with fine sand, but when carried about it was covered with a thin coating of bees' wax. Let us suppose the pedagogue sets the young Roman scholar the addition of the following sums :—

$\overline{\text{III}}$ DCCXCVIII.
M CC LXXXIX.

* "Where boys descended from great warriors carried their counters and tablets slung over the left shoulder."

It is quite clear that the addition of these to be set down in Roman numerals at once would be a difficult, almost impossible task.

Our young patrician proceeds thus. With a pointed iron *stylus*, he draws four incised lines horizontal and four perpendicular, thus: —



The Roman system of numbers, as we have already seen above, was perfectly decimal in its scale. There is no difficulty therefore in supposing the bottom line to represent units, the second line tens, the third hundreds, and the top line thousands. The left hand and centre columns are for the addenda, the right hand one for the sum. The column for the sum may equally well be placed on the left. It does not make the slightest difference. Every schoolboy and arithmetician was provided with a bag or box of small stones, usually fragments of white marble, or limestone. Hence they were called *calculi*, the diminutive of *calx*, limestone. From the use of these *calculi*, the working out of arithmetical problems took the name of *calculatio* which has adhered to all such problems ever since, though the *calculi* have been for many ages abandoned.

In setting down the addenda, we begin with the top line, and place thereon three counters for 3,000. A counter on the spaces between the lines is five times the value of a

counter on the line below. For 700 we place a counter on the intermediate space between hundreds and thousands, which represents 500, and add two on the line for hundreds. For 90 we place four counters on the tens line, and one for 50 on the space above. The 8 is marked by three counters on the bottom line, and one for 5 on the space.

The second portion of the addenda, 1289, is set out in the second column in a similar way.

In making the addition, we commence with the bottom line of units, of which the addition is 7. We place two counters on the bottom line of the vacant column, and one for 5 on the space. We next add the two fives in the space, making 10, for which we place a counter on the second line. The counters on the second line make again 7, with which we deal as before, adding two tens, and putting one for 50 on the space. The three fifties in the second space make 150; we leave one on the space. The other two added to the four 100s on the third line make 500, which added to the counter for 500 in the upper space make 1,000, for which a counter is placed on the top line, in addition to the four already there. The addition then is easily read 5087, or

$\overline{\mathrm{V}}$LXXXVII.

Subtraction, multiplication, and division were easily worked out by the same means.

This method of arithmetical process prevailed throughout Europe from the time of the Romans through the middle ages as late as the fifteenth century, when it began to be superseded by the introduction of the Arabic figures, first in Italy and Spain, and afterwards in France. The use of the abacus had not disappeared in England and Germany even in the time of Shakespeare. In the *Winter's Tale*, the clown in reckoning says—"Every 'leven wether (so many) tods; every tod yields a pound and odd shilling; fifteen hundred

shorn, what comes the wool to? I can't do it without *counters*." In a work published in 1540, entitled *Arithmetic or the Ground of Arts*, by Robert Recorde, occurs the following passage:—

"Now that you have learned arithmetick with the pen, you shall see the same art in counters, which feat doth not only serve for them that cannot write and read, but also for them that can do both, but have not at the same time their pen or tables with them."

Even so late as 1662, in a Treatise on Arithmetic published in Germany, there is a chapter devoted to "Arithmetica Calcularis," which is said to be in common and general use among merchants.

It must be understood that the abacus or counting table of the middle ages had assumed a more permanent form by the substitution of wires for the lines in the Roman tables. It will easily be seen that four balls running on each wire for the decimal numbers, with a single ball on the intermediate spaces for the fives, would serve as a ready reckoner, without the labour attending the Roman mode by means of lines and counters. In this form it is still in common use at the present day in Russia, where the abacus lies on the counter in every native shop, and is resorted to in every calculation.

The Court of Exchequer arose in the middle ages out of this method of computation, or one analogous to it. The name is derived from *Scaccarium*, which was again from an Arabic word signifying a chess board divided into squares. The Board of the Exchequer was a table about ten feet long, and five feet wide, covered with black cloth, divided by white lines at right angles to each other. The judges, tellers, and other officers were seated round it. The counters employed were small coins.

I may allude in passing to a curious and rather whim-

sical adaptation of the Roman notation in the middle ages. The Latin numerals were all letters of the alphabet, or might be expressed by them. Since each numeral gave the same value wherever it was placed, not requiring any special order, it was possible to express a number or a date by letters dispersed at intervals in a sentence. Such inscriptions were called *Chronograms*, and were much used in the sixteenth and seventeenth centuries.

The following are specimens. The first is in Dutch, at Leyden in Holland, and commemorates the date of the celebrated siege:—

NAE sWARTE hVNGERNOOT
GHEBRACHT HADDE TE DOOT
bINAEST ZES dVISENT MENSCHEN;
aLs'T GOD DEN HEER VERDROOT
GAF hI VNS WEDER BROOT,
ZO VEEL WI CVNSTEN WENSCHEN.*

Each W counts for two Vs.

M	...	stands for	...	1000
Four Cs	...	"	...	400
Two Ls	....	"	...	100
Fourteen Vs	...	"	...	70
Four Is	...	"	...	4

Giving the date 1574

The second is in Latin, on a monument in the Burg Strasse, at Innsbrück:—

* After black famine
Had brought to death
Nearly six thousand people;
Then God, the Lord, grieved,
He gave us bread again,
As much as we could wish.

qVIete DaMIs fILIa athesIs,
Inter nepas qVIa pro te VIgILat,
tVVs pIVs pater VIgILIVs.*

Here—M ...	...	...	is ...	1000
D ...	...	...	" ...	500
Three Ls ..		...	" ...	150
Eight Vs ...		...	" ...	40
Thirteen Is		...	" ...	13
				A.D. 1703

During the long period of time in which the Latin system of notation was prevalent throughout the civilised world, it might naturally be expected that alterations and improvements would be propounded and adopted. To some of these I will presently refer, but we must now turn our attention to a more distant part of the world.

The Hindoos, from remote antiquity, have possessed a very perfect system of arithmetic, with a decimal scale carried to a high order of numbers. Their enormous astronomical periods, and the extravagant antiquity of their chronology, implied and required considerable arithmetical skill. They possessed the science of Algebra long before it was known in

* Rest secure, O Damis, the daughter of Athesis, for thy pious father, Vigilius, from the heavens watches over thee.

Vigilius, or Virgilius, was an Irish saint, who lived in the 8th century. He is said to have been accused to Pope Zachary of having taught heresies on the subject of the Antipodes; but he went to Rome in person, and justified himself by proving to the Pope that the Irish had been accustomed to communicate with a transatlantic world.

He went forth as a missionary to Germany, where he became the apostle of the Boii, and was made Bishop of Salzburg; hence his popularity in the Tyrol. He is mentioned in the Irish *Annals of the Four Masters*, which states that Ferghil the Geometer, Abbot of Aghabo, died in Germany in the thirteenth year of his bishopric. Notwithstanding the suspicion attaching to his orthodoxy, he was canonised by Pope Gregory IX., in 1233, and became the patron saint of Innsbrück.

Europe, and to them we are indebted for an introduction into the higher branches of mathematics.

Their progress in arithmetic was greatly facilitated by their early acquaintance with a simple and effective system of notation, to which they ascribed a divine origin.

As this mode is absolutely identical with that in modern use, it is unnecessary to explain it further than to intimate its three leading principles:

1. That only nine digits are employed for numbers, however large.
2. That the digits acquire their decimal value by the position in which they are placed.
3. The introduction of the cipher 0, or zero, by which the value of the digits is regulated as circumstances require.

It is asserted by Oriental scholars, with a considerable degree of probability, that the Sanskrit digits were originally the initial letters in a very ancient form, of the names of the first nine numerals, as it happened fortunately that each began with a different letter.

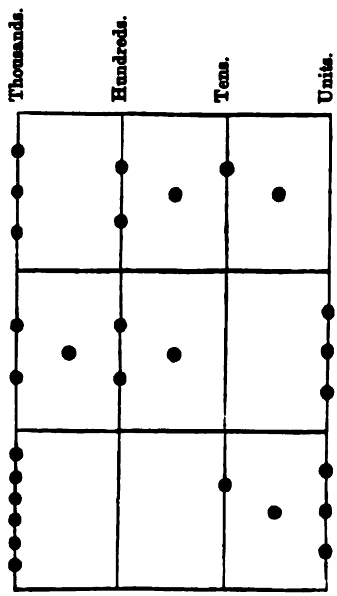
They are as follow :—

1	2	3	4	5
१	२	३	४	५
6	7	8	9	0
६	७	८	९	०

The date and mode of introduction of this system into Western Europe, and the channel by which it was introduced, have been the subjects of very learned and animated controversy. By some it has been held that such successive improvements had been made in the Roman numeration that the system of the abacus, in its essential principles, was identical with our modern written numeration, very little

having been added from the East. Some have maintained that the Arabic numerals were brought into Western Europe by way of Greece and Italy. Others point to Spain as the source from which they were introduced into France, Germany, and England. Time and space would fail to enter into all the arguments and review the proofs by which these various theories are supported. After a careful investigation of all the authorities on the subject, I will briefly state the conclusions which appear to me on the whole to be the best sustained.

I have already described the abacus as it existed in its earliest form amongst the Romans, in which the lines increase in value decimally from the bottom upwards, the calculations being worked horizontally. Let us now imagine the abacus turned up in a vertical position, thus :—



the two upper sets of spaces for the figures to be worked,

the lower for the result. Let us set down the following sum for addition :—

MMMCCLXV	...	3265
MMDCCLIII	...	2753
$\overline{\text{VI}}$. XVIII.	...	6018

This is still the abacus in its simplest form.

As the counters are only employed to express the numbers up to ten on each line, it is just as easy to use the numerals themselves thus, adopting the same problem :—

iii	ii	lx	v
ii	vii	l	iii
vi		x	viii

Imagine now the lines effaced, and the numbers remaining with a space or point between each. They will stand thus :—

iii .	ii .	lx .	v	= 3265
ii .	vii .	l .	iii	= 2753
vi .	.	x .	viii	= 6018

We have here, it will be at once seen, the principle of our

modern numeration — value by position, increasing by tens from right to left. Two defects, however, will be at once perceived—the want of a simple sign for each digit, and the want of an expression for zero or nought. To this point it is believed arithmeticians had arrived when the introduction of the Arabic numerals supplied the missing link.

It has happened in this as in many other cases of invention, that where a want has been felt there has been a gradual approximation by tentative efforts towards its supply, until some practical genius has struck the chord which has blended the scattered notes into harmonious completeness. It was thus with the steam-engine, with the construction of railways, with the electric telegraph, and many other inventions which exercise an important influence on human affairs.

The philosopher Boethius, who flourished in the latter part of the fifth century, and who is principally known by his *Consolations of Philosophy*, in a treatise on geometry, has given a system very like the upright abacus described above. It is a disputed question whether the Arabic numerals were known to Boethius. He mentions nine figures or signs, which he ascribes to the Neo-Pythagoreans, and which as given in some MSS are very like the Arabic; but these MSS are of much later date, and the passage is wanting in some copies, leading to the impression that it is spurious.

In the tenth century a Benedictine monk of Auvergne, Gerbert, who was afterwards Archbishop of Rheims, and was finally raised to the Papal chair under the title of Sylvester II., wrote largely on arithmetic and geometry. He felicitates himself in one of his letters on having procured a copy of the MS of Boethius, whose abacus or geometrical table he reproduced in his own work.

Those who favour the opinion that the Arabic numerals

were introduced from Spain point to the astronomical tables formed and prepared by Arabian astronomers, under the direction of Alphonso, king of Castile, and published at Toledo about A.D. 1252, in which this mode of notation was employed. There is, however, evidence of a work of the beginning of the thirteenth century, written by Leonardo Pisano, for the purpose of introducing into Italy the Arabic system. The period, therefore, between the treatise of Gerbert, which contained the furthest advance of the Roman system, and the complete introduction of the Arabic, is not at the utmost more than two centuries.* We must not at the same time overlook the influence of the Crusades, which contributed in a very important degree to introduce into Western Europe the arts and knowledge of the East.

The earliest authenticated instance of a date in Arabic numerals is in a MS of St. Augustine, presented by Boccaccio to Petrarch, and inscribed by the latter with the year 1855.

In the thirteenth century, Italy, and especially Tuscany, stood at the head of the commercial world. The Florentine merchants readily availed themselves of the advantages of the new method of numeration. The mercantile system of book-keeping was invented by them, and by their influence diffused throughout Europe. Some time elapsed before the new figures were inscribed on monuments and buildings. The earliest specimen I have met with is on a tombstone in Santa Croce, Florence, 1424, immediately under which is another inscription in Roman numerals—MCCCCXXX.

The new system was introduced into England in the fourteenth century, though there is a single instance of its

* See on the subject *Revue Archéologique*, 1856–7, two elaborate Papers by M. Henri Martin; M. Chasles, *Aperçu sur l' Origine des Methodes en Geometrie* (Bruxelles, 1837); Max Müller, *Chips from a German Workshop; Encyclopædia Metropolitana*, an exhaustive treatise on Arithmetic, by Dr. Peacock.

use in the previous century. In a document of the 10th Edward 1st (1282), the word "*trium*" is written "*3um.*"

In the 19th Edward 2nd (1325, February 4th), there is a warrant from Hugh le Despencer to Bonifez de Peruche and his partners, Italian merchants, to pay forty pounds. In the body of the document the figures are in Roman letters. Outside, the payment is endorsed by one of the Italians ı ʒ χ ς (1325).* If this, as there is every reason to believe, is authentic, it is very remarkable, as Mabillon, in the whole course of his inquiries, and after the examination of more than six thousand documents, could find no specimen earlier than that of Petrarch (1355).

The first employment of the figures in England was naturally in the preparation of kalendars, of which some fine specimens exist in the British Museum, commencing in 1398. It is natural to expect that at the outset many mistakes would be made in the application of the new figures. Thus, in a MS of the fourteenth century, quoted by Mabillon, there is a curious mixture of the old and new methods:—12 is written X 2, 31 is XXXI, or 301, 42 is 402, evidently by a scribe who had only imperfectly comprehended the principle.† The new system was called *Algorismus*, from an Arabic word, which would point to Spain as its origin. Many treatises "De Algorismo" were written in the fourteenth century to explain the use of the figures.

Chaucer, in his poem of the *Book of the Dutchesse*, alludes to this:—

* *Archæological Journal*, vi., 291.

† Even in more modern days, some curious dates have occasionally been appended by rustic artists on tombstones. At Chave Priory, in Worcestershire, a person who died at the age of 39 is stated on the headstone to have been 309 at his decease. At Bickenhill, Warwickshire, a tombstone is erected to the memory of Mrs. Ann Smith, and records that she "died a maid, and deceased in 1701, aged 708."—Thoms's *Human Longevity*, 1873.

"Shortly it was so full of bestes,
That though Argus, the noble countour,
Sate to reckon in his countour,
And reckon with his *figures ten*;
For by the *figures newe* all ken,
If they be crafty, reckon and nombre,
And tell of every thing the nombre.
Yet, should he fail to reckon even,
The wonders met me in my sweven"

The first appearance of Arabic numerals in printed books is in a work published in Louvain in 1476, called *Fasciculus Temporum Antiquorum.* They are not found in any of the works printed by Caxton; but in the *Myrrour of the World,* issued by him in 1480, part of which treats of "Arsmetricke or Algorithm," there is a wood-cut of an Arithmetician sitting before a table, on which are tablets with these figures upon them. In 1506, another edition of this work was published by Lawrence Andrews, printed by Pynson, in which the figures and common operations of arithmetic are exhibited under their present form.

The progress made was very rapid. In 1522, Cuthbert Tonstall, Bishop of Durham, published his treatise "De Arte Supputandi," printed by Pynson, which displays a perfect acquaintance with the most improved state of the science.

The accounts of merchants in England were kept in Roman numerals until the middle of the sixteenth century.

The Churchwardens accounts in the City of London parishes were kept in the same way down to the year 1609, in which year the Arabic figures make their appearance, but, at first, in a somewhat awkward and tentative manner, thus:—

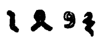
£	s.	d.
00 ·	03 ·	04
02 ·	12 ·	00

The most interesting illustrations of the change in notation are the inscriptions on monuments and buildings. Before the subject had been thoroughly investigated in modern times, ideas of the most absurd character prevailed as to the dates inscribed on buildings. The early Arabic numerals were so different from those now in use, and varied so much in their form, that it was natural mistakes should be made by persons ignorant of their history. Thus, an inscription on a chimney-piece at Helmdon, in Northamptonshire, was read as A.D. 1133. Later investigation has shown that it is really 1533. Another at Colchester, said to be A.D. 1090, turns out to be 1490. In our own neighbourhood, it is usually asserted that Sefton Church was built in 1111, on the authority of a date inserted in Arabic numerals over the south porch. The incongruity of such a date with the style of the building, which is Gothic of the latest period, indicates that there must be a discrepancy somewhere. The real date is 1511, but at that period the figure 5 was frequently written with so slight a curve, 1ʕ11, as to be mistaken for 1.

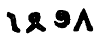
The earliest ascertained date in Arabic numerals in England is inscribed on a Lych Gate at Bray, in Berkshire:—

 1448.

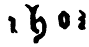
Another of similar character exists at the Episcopal Manorhouse, Bishops Waltham, Hants :—

 1493.

The following is from a painted window in the Hospital of St. Cross, near Winchester:—

 1497.

On the mantle-piece of a fire-place in the same building is the following:—

 1503

The letter *h* for 5 appears singular, but it occurs in the *Chiffres Vulgaires de France*, given by De Vaines, in the *Dictionnaire de Diplomatique*, i., pl. 4. It is found also on a brass in the church of St. Mary Coslany, Norwich. This use is of high antiquity, for it is identical with the character *quinas*, the fifth of the numerical symbols used by Gerbert in his work of the 10th century.†

It will be seen that the above figures differ materially from those now in use, whilst the Italian figures have remained nearly the same from the commencement. This would give countenance to the opinion that these figures were not first introduced into England from Italy.

The adoption of the Arabic numerals gave such facilities to arithmetical calculation that the study became very popular, and the power of combination of numbers was illustrated in a variety of ways which would have been impracticable under the Roman system. Amongst others was the formation of the magic square, in which the numbers are so disposed, in parallel and equal ranks, that the sum of each row, taken either perpendicularly, horizontally, or diagonally, is equal.

11	24	7	20	3
4	12	25	8	16
17	5	13	21	9
10	18	1	14	22
23	6	19	2	15

† *Archæological Journal*, vii., 76.

Any five of the sums in this square taken in a right line make 65.

There is a singular property of the number 9. When 9 is multiplied by any number, the sum of the digits composing the product, when added together, will always give 9, or a multiple of 9.

Thus $8 \times 9 = 72$ and $7 + 2 = 9$.
$4 \times 9 = 36$ „ $3 + 6 = 9$.
$43 \times 9 = 387$ „ $3 + 8 + 7 = 18$—or $9 + 2$.

Another curious relation of 9 is that if we take any number and reverse the order of the digits, if the one sum be subtracted from the other, the remainder will be either 9 or a multiple of 9, and consequently the sum of its digits will be nine or its multiple.

Thus, if we take - - - - -	76
Reverse the order - - - - -	67
The remainder is - - -	9
Or take a larger number - - - -	1784
Reverse the order - - - - -	4871
Difference - - - -	3087
The sum of the digits is - - -	$18 = 9 \times 2$

These problems might be multiplied *ad libitum.*

These are merely specimens of the wide field open to investigation in the properties of numbers, facilitated by the Arabic numerals.

Particular numbers have had special associations in all ages of the world. The Platonists and Pythagorean philosophers adopted numbers as the types and emblems of philosophical principles to which mystical properties were

attached. The learned Peter Bungus, in 1618, issued a quarto volume of 700 pages, illustrating all the properties of numbers, whether mathematical, metaphysical, or theological, incorporating according to his own view the whole system of Christian and Pagan theology. The sixteenth and seventeenth centuries were especially fertile in works of this description. Each numeral has its own peculiarities.

The number 2, according to Pythagoras, represented the evil principle, and has been counted as unlucky in the history of most European countries.

In England, the second monarch of each name has been generally unfortunate. Ethelred II., surnamed the Unready, was forced to abdicate. Harold II. was slain at Hastings. William II. was shot in the New Forest. Edward II. was murdered. Richard II. was deposed and put to death. Charles II., after the death of his father, was driven into exile. James II. was deposed and exiled. George II.'s reign was marked by disaster and rebellion.

In France, Germany, Spain, and other parts of Europe, the corresponding monarchs have been almost equally unfortunate.

The numbers 3 and 7 were the subject of particular speculation with the writers of that age; and every department of nature, science, literature, and art was ransacked for the purpose of discovering ternary and septenary combinations. The old monk, Fra Lucas di Borgo, the author of the first printed treatise on Arithmetic, has enlarged upon the associations of the numeral 3 in a quaint and amusing manner. He says "There are three principal sins—avarice, luxury, and pride; three sorts of satisfaction for sin—fasting, almsgiving, and prayer; three persons offended by sin—God, the sinner himself, and his neighbour; three witnesses in heaven—the Father, the Son, and the Holy Ghost; three degrees of penitence—contrition, confession, and satisfaction, which Dante

has represented as the three steps of the ladder which leads to purgatory." In this way the worthy father proceeds page after page, concluding with the observation that "all things are founded in three—that is, in number, in weight, and in measure."

Three occurs very frequently in Scripture. Three angels appeared to Abraham; Moses was hid three months; the Jews were bound to appear before God three times every year; the priestly blessing was three-fold; Daniel prayed three times a-day; after three days Christ rose from the dead; Peter's vision was repeated three times; God is described in a three-fold form; there are three witnesses to the truth.

Four is not quite so remarkable as three, but we have the four rivers of Paradise; four judgments on Jerusalem; four living creatures in the visions in Ezekiel and the Apocalypse; the four beasts with four horns; the four winds of heaven; the four cardinal points; the four quarters of the globe, &c.

The number 5 fills a distinguished position. Joseph presented five of his brethren to Pharaoh; Benjamin's mess was five times as great as those of the others; the armies of Israel went up five in a rank. Everything relating to the Tabernacle was arranged in fives—there were five curtains, five pillars, five bars, and five brackets; the curtains were five cubits high; the altar was five cubits long; the peace offering consisted of five rams, five goats, and five lambs. David chose five smooth stones of the brook wherewith to slay Goliah. Christ fed the multitude with five barley loaves. There were five wise and five foolish virgins. The Pool of Bethesda had five porches, &c.

The most curious monograph on the number five is the work of Sir Thomas Brown, entitled *The Garden of Cyrus, or the Quincunx mystically considered.* In this learned

treatise, history, nature, analogy, conjecture, imagination are all laid under contribution to illustrate the numeral five, especially in its quincuncial form. He was the first to point out what an important part the number five plays in the leaves of plants, the calices of flowers, the radiations of stems, &c., which he pursues at great length with a wonderful amount of ingenuity and learning.

Seven has probably a greater number of associations than any other of the digits.

In the year 1502, a work was printed at Leipzig, entitled *Heptalogium Virgilii Salzburgensis*, in honour of the number 7. It was composed for the use of the students of the University, and consisted of seven parts, each containing seven divisions.

The number 7 was held in peculiar honour by the Jews. It was considered the number of perfection, as being composed of 4 and 3, the signature of the universe and of God, and therefore signifying the union of God and his creatures. It was sacred, the seventh day being sanctified as the day of rest. Noah took clean beasts into the ark by sevens. Pharaoh's dream had seven fat and lean kine, and seven ears of corn, typifying seven years of plenty and seven of famine. Seven Sabbaths intervened between the offering of the first fruits and the day of Pentecost. Seven times seven years completed the period of the Jubilee; the Passover and the other feasts lasted each seven days. Balaam built seven altars, and offered on each seven oxen and seven rams. In the beleaguering of Jericho, seven priests bore seven trumpets; the army compassed the city round about seven days. The golden candlestick had seven lamps; the blood of propitiation was sprinkled seven times.

In the New Testament, there were seven deacons in the primitive church; there were seven churches in Asia to whom the Apocalypse was sent. John saw seven golden

candlesticks. Seven angels stood before God. Seven thunders uttered their voices. The dragon had seven heads and seven crowns. The angels had seven last plagues and seven vials of wrath.

In the secular world, the number 7 has played a distinguished part. There are the seven wise men of Greece, the seven wonders of the world, the seven champions of Christendom, &c.

This part of the subject might be pursued at considerable length; but probably enough has been said to illustrate the fancies and associations connected with the several digits.

I have endeavoured in the above pages to present, in a compendious form, a general view of the origin and history of the numerals, oral and written. It is necessarily very imperfect. Though many volumes have been written upon the subject, it is probable that at the present day, with such a copious flood of literature struggling for notice and attention, a brief synopsis like this may embrace all which the general reader may desire to know.

PHILOSOPHY WITHOUT ASSUMPTIONS.

Part III.

By THOS. P. KIRKMAN, M.A., F.R.S.

We have had recently forced on our attention, in a more startling way than has been wont, the war which for thousands of years has been waged between two opposite schools of thought, about the cosmos and its cause, its forces and its purposes. I am here to take my part in this war, not as a theologian, but as a student of science, desiring to build up a philosophy without assumptions. The scene of combat, which can no longer be ignored by philosophical societies, is border land; and one great question is of boundary, that fertile source of quarrel; of boundary between the domain of intellect, which deals with the finite, and that which in you and in me is nobler than the intellect, the soul, with her "I ought" and all her promptings and aspirations toward the infinite. The two hostile camps are not to be described from my point of view as theistic and atheistic; I shall seldom have to use the ugly word atheism, far too readily employed by many. One school I shall designate as the Matter-and-Must-be School, the other as the God's-Will-and-Work School. It were easy to say Theothelite and Theurgical; but I had rather speak the English tongue.

The Matter-and-Must-be School comprises, I doubt not, both Theists and Atheists; but both are tolerably in agreement that, whether an intelligent and conscious Cause of the Universe exists or not, it is unphilosophical and unworthy of Science to make any reference to His will or operation, either in framing or answering questions about the Cosmos of Being and Life, as it is, was, or will be; yet they do not all

speak with the same disdain of the notion of a divine plan or energy in both Cosmology and Cosmogony. Numbers of the Matter-and-Must-be doctors disown the name Atheist, even while they decline unequivocally to confess themselves believers in a God. Others affirm loudly their faith in a Creator of all, or at least in a Creator of all but matter, which He at the beginning equipped and organised, by bestowing on it such inherent and mighty energies, and such properties of mathematical accuracy, that the cosmos has gone on by the force of this matter without any co-operation on His part, and must of necessity continue to go on, even if it were possible for its author to forget it. The atheists differ from both these sections of the school by sturdily and often contemptuously denying the being of an infinite Intelligence, and by the dogma that the forces of blind unconscious matter are necessary and eternal, producing by their chaotic and perpetual conflict all that exists of order and life, of thought and will.

Of the God's-Will-and-Work School I shall not attempt to give any account, beyond the statement of what I myself hold to be the truth, in opposition to the Matter-and-Must-be teachers. Others may pretend, on these great limiting questions, to tell what they know; I am content to utter what I believe, not as a mere creed received from authority, but as inference, which I do not call demonstration, from what I do know; and I am ready to show the ground of my beliefs, and to point out, I trust to your satisfaction, that they cannot be denied or evaded without absurdity or unproved assumptions. You will gather my notions from what follows. It suffices for the present that I state, not as preaching, but as endeavouring to talk, not cosmical, but *soul* science, that I believe in "One living and true God, everlasting, without body, parts, or passions, of infinite power, wisdom, and goodness, the maker and pre-

server of all things visible and invisible." More precisely, I hold that this God in the beginning made all things, not *ex nihilo*, but out of nothing but Himself: that, I believe, is nearly orthodox, whether what follows be so or not. I believe that this God is at this moment, exactly as at the first, if there ever was a first, making all things out of nothing but Himself; that He can, if He chooses, cease to make; and that if He should for one second suspend His will to work, all things but Himself for that second would cease to be. Further, as a scientific thinker, I believe in a trinity in unity; namely, I believe first in God the Unrevealed and Unrevealable; secondly, in God the Revealed; and thirdly, in God the Revealer. That is, I hold that, if my power of thought and knowledge could be expanded to set me far above the loftiest finite intelligence, so that I could answer scientifically every question I knew how to ask about this cosmos, I should be, all the same as now, affirming and adoring, with thankful and exulting strains, the Unrevealed and Unrevealable save to Himself, who is not only the Revealed, πάντα καὶ ἐν πᾶσι, but infinitely in His perfection transcending all,

> "And hangs Creation, like a precious gem,
> Though little, on the footstool of His throne."

This may be noted by those who think that a nickname is the finest of arguments, and who show their sagacity by crying, Pantheism. Secondly, I believe in God the Revealed, outwardly, in all this marvellous universe, according to our attainments, to us and other finite intelligences. Thirdly, in God the Revealer, by whose indwelling and teaching only in this mind, heart, will, and conscience, I know anything of Him or His ways, and am able to do His commandments. And these three are one and the same God. All this I state in reference to myself, without the tropes of substance,

person, and the like, under which the churches teach of the Father, the Word, and the Holy Ghost; for I do not see the value of those figures in theological science, nor do I admire their pedigree. The order in which I acquired these conceptions of God is probably the inverse of that in which I impart them.

It is a very old statement of my tenets that I have made. Thousands of thinkers for thousands of years, from the sages among our Aryan fathers, have held, as I do, that life, thought, and will are the direct gift of the indwelling God, not commensurable on any scientific scale with found force and motion; and that all attempts to evolve, as they say, either will or life out of so-called matter, are a tissue of ridiculous circles and sophisms: nor am I alone in my strong tendency to believe that all force is will-force; for example, that the force which I encounter when I push at that wall is verily the manifestation of a present conscious will, not my own.

To thinkers of the school to which I belong, the term *matter* of the opposite school stands for nothing inward or outward, besides the six letters which compose it. As to our friend *Must-be*, I expressed, in my paper of our last session but one, my estimate of him. All that I beg to repeat, with tenfold logical scorn. Why should I, a free-born Englishman, do reverence to the most magnificent, peremptory, and arrogant of gentlemen, just because neither he nor any of his friends has a syllable to say in support of his pretensions? No man ever yet answered a question by *must be* or *can't be* if he knew how to give a reason; and if a good reason be given, the answer is a *must follow*. Think it over as long as you please, and in any presence, however grand and imposing; you will find that the "must be" and "cannot possibly be" of the Necessarians and all that school is, in every case, either the refuge of despairing, or the mask of pretentious

Ignorance. And I firmly believe that liberty, charity, and peace, as well as truth, have quite as much to dread from the philosophistic tyranny of Thus saith Must-be, as ever among Jews or Gentiles from the priestly tyranny of Thus saith the Lord.

I hope that many of you do me the honour to remember that, in my former paper on this subject, I started with the proposition "I am," as the only one of which I could not without absurdity express a doubt or demand a proof. Let me once for all beg you to remember that this "I am" always stands for "I am thinking, and I know I am thinking:" it is not an assertion about Being, but the affirmation of my conscious act, when at any moment examining my beginning of philosophy; and it is in vain that learned Sophists try to cloud that first position by quibbles about the etymology and metaphysics of the verb To Be. If a wise man, when you affirm your "I am," puts his finger on your chest, and demands, Yes—but what is *being ?*—just beg him to write down his ideas on that subject.

In studying the record of consciousness in memory, controlled by its present witness, I showed the vast importance of a radical distinction, which has been too little considered at the beginning of philosophy, between my active and passive consciousness, a distinction known to me by the presence or absence of my acting will-force, so that the fundamental "I am" comprises, in the active phase, the fundamental "I will."

The first question that I proposed to myself was this— Can I find with demonstration, and without unproved assumption, that there is in existence any other thing or being than this Ego which, without definition or affirmation of my body, says "I am"? Here I mean by *thing or being* that which I may find, not something which I cannot find nor demonstrate. In reply, I worked out a valid

demonstration, free from all assumption, that I am verily in a cosmos which is divided into loci of acting forces, my own body being one of them found by me, each locus within my reach being found defined and measured to me both as to space and force by my own free will, and by that alone. The use of this first step should be borne in mind: it is to confute those, whether theists or atheists, who insist on the absolute necessity of beginning their philosophy with the assumption of themselves and their surroundings, themselves and their correlatives, themselves and their events, as they phrase it, a pretended necessity under cover of which they make what assumptions they please. These assumptions, they say, must be, must be made! Thus they set out at first with their great magician "Must be," and with unproved assumptions, on which they may build, if unchecked by determined Doubt and Logic, a domination as dangerous as that of Popes and Councils.

In thus finding force acting in various loci or spaces, I showed that I could really find nothing more than the force in action, and the defined locus or space in which it acted. I could discover nothing of what they call matter, distinct as agent, seat, or vehicle, from force in loco. On this it may be worth our while to dwell a little. I hope—if you will try to do that difficult thing, to sit there as determined sceptics, dismissing prejudice—to carry you with me, and to make you feel the firmness of your footing, in your own "I am" and "I will."

There is not a little confusion in many minds about this force and matter. I have found even engineers who have disliked the use of the term force, except when applied to the action of machinery and tools, or to the momentum of moving bodies; and they have pitied my muddle in designating as force what common sense calls matter.

I trust I had you with me in this negative—of immense

importance — that I cannot find any thing or being, besides my remembered and changing self, except by the challenge of my will-force in active consciousness. That is treated with considerable illustration in my essay *On Matter, Force, and Atheism*, which is the latter part of my little treatise on *Church Cursing and Atheism*, published by the well-known Thomas Scott, of Upper Norwood. Although the tract, with its defiant title and queer mixture of polemics and metaphysics, is hardly at all known, I do not regret having gone to the expense of printing it. The time may come pretty soon when Divines and Philosophers may condescend to ponder it. I hope it will outlive many more pretentious volumes, although it did not come out with what the trade reviewers call the requisite 'literary finish,' that is, in the proper form and channel, at a proper price, and with the proper expenditure of cash.

Let me try to show you whither I am leading you. My notions are very old. The best of them were all stolen from me a hundred years ago, by that great genius Boscovich, whose contributions to a scientific view of the cosmos for my faculties incomparably outweigh all that has been done by Microscopists and Physiologists, and especially by those very lively writers, the Biologists, Psychologists, and Evolutionists, with their grand Sticktogetherations of Sticktogethernesses, or in their more learned Latin, their Integrations of Coherences.

I believe with Boscovich, that the smallest locus of force is a point without parts, and I agree with those investigators who think that dynamical science will eventually begin where geometry long ago began. The starting conceptions will perhaps be stated thus: In Geometry, from points which have unchanging position and no parts; in Dynamics, from points which have changing position and no parts.

In the definition that dynamical points change their

positions, the changes being referred to an adequate cause, working by laws depending on the distances and numbers of related points, and the movements being for all finite observation and computation continuous, all that we mean by force and inertia in dynamics is logically included, and would be stated in definitions following.

And can we maintain that there is any one force-point for a definite time at rest? If, as most men of science believe, every one is behaving to every other in the universe in attraction, equilibrium, or repulsion, by rigorous laws, expressible in terms of distance between the points, one would think it impossible that any should be in repose, if it be not the dynamical centre of all.

I believe also with Boscovich, what indeed the Materialists generally affirm of their atoms, that no two force-points are in contact. All that is within my reach for observation or experiment, of a solid body hard or soft, I conceive to be a film infinitesimally fine, of superficial molecules, or primary groups of force-points, which are prevented from leaving those behind them by attractions often of tremendous power, and from more nearly approaching them by repulsive forces. The distance between the molecules may be, if we could see and measure them,—in a bit of glass, for example,—very great, compared with the size of the molecules, whose component parts, whether atoms or force-points, are equally unknown as to their arrangements and distances. Thus the old puzzle of the infinite divisibility of matter is both silly and useless; silly, because it is absurd to talk of the performance of an infinite succession of operations; and useless, if all bodies are all at this moment divided to a degree beyond which division is impossible, in the points without parts.

From the molecules upwards, considering molecules as primary aggregates of force-points or atoms, the notions of

Boscovich and the God's-Will-and-Work school about bodies differ little from those of the Matter-and-Must-be teachers. And, practically, downwards to the components. So long as you confine yourself to the departments of what may be termed Cosmology, and keep yourself far enough from the domain of Cosmogony, which has recently been placed under the entire control of these gentlemen, you may make your ultimate atoms as small as you please; indeed, for all conception of men and angels, simply zero. Ask one of these Matter-doctors, What is the size of your ultimate atom? He will probably reply, Write first your decimal point; after that a few billions of zeros, and put a 1 or some other figure at the end. That will do for the diameter in inches of our atom, in the molecules either of light or of iron. If, enjoying your task, you beg his permission to add a few score millions more of zeros before the final figure, With all my heart, he will answer; you may carry your line of zeros from here to Aldebaran, if only you put down the 1 at the end. If you venture to inquire of what importance the 1 can be in that remote decimal place, he will say, somewhat curtly, That is our business, and a long way out of your depth; that belongs to Cosmogony. Besides, he will add, our good friends, the Atheists, who are pious people, must have an eternal cause of all; they cannot do without a deity. Would you break the heart of their Theotokos Must-be, by kidnapping her baby, and robbing them of their religion and their god? 'Is it not a little one?'

If I can find nothing which is not my changing self, save by my will-force, it is plain that I cannot find force in any body or any locus, save by that instrument.

You will not go with me, unless you are satisfied upon the truth of two most important theorems, one about our

experience in any moment, the other about a train of reasoned thought. These theorems are :—

1. My will is my only force-finder.

The second is :—

2. In my every train of reasoned thought concerning acting-force in the cosmos, if the whole be fully written down, and no step omitted, this preposition must stand at the head of all: I will in all conflict with force, and I know that I will. For on my certainty that this is true, depends, and out of it flows, all my cognition of other force. If I did not will, and know that I willed, I could never find force, nor know it in action.

Test the truth of these theorems by an example. Suppose that you had reason, or for argument's sake thought fit, to doubt whether there be any force acting in the wall which is apparently opposite you, such as would prevent you walking through that locus. Let me beg you to place yourself in that attitude of doubt. If you would think clearly, you must learn to be a good doubter. We have so many lame philosophers, because we have so few sound doubters. Doubt is the grand key to real knowledge, in spite of us bishops and parsons. One advantage of mathematical training is that it teaches a man to hold a doubt in his teeth like a lion, till it is rent out by demonstration irresistible. Placing yourself in that frame of scepticism, ask yourself, What amount of evidence would you require to remove the doubt by verification for yourself? Would hard looking at the wall suffice? I presume not, if you are a good doubter. Would it be enough if, at your request, I walked up to the wall, and you saw and heard me strike it with my stick? If it would, I fear you would not do much in mathematics, nor should I recommend you to study the calculus of probabilities. You would be mistaking an inference, about which error or deceit is possible, for actual

found proof. For real proof you would walk up to the wall, and test it by the challenge of your will, with your own effort. Resistance so found to the force of your will would be demonstration of a force acting against you in the locus, as good as your evidence of your *I am* and *I will*. And if you were asked, while your arm was pressed against the wall, Whence comes your certainty that force not your own is acting there? you would answer, Because I will in act, and I know that I will. If you did not know that you willed, you could not know that you were resisted and stopped, nor could you find the force in action against you.

There are, I presume, none here of those who cannot understand that, when they push against the wall, they are met by a reaction equal to their own effort, and are resisted by an opposite horizontal force due to friction and molecular action. Such persons require a lesson in elementary statics; but every child can see that if no force at all was at work in the wall opposing his will-force, his arm would go through the wall, no matter what matter were there.

If you began by a doubt of acting force in a moving body, such as a swinging pendulum or rolling wheel, you would find, in the same way, that the only demonstration that could destroy the determined doubt would be the encounter of your own will-force. Our President, in his opening address, has lucidly exposed the error of those who pretend that we become acquainted with things around us only by the action of the physical organs of passive sense, a mechanical action, as some of them say. This error is most glaring in the explanation which it pretends to give of our cognition of acting force. We can no more see force than we can hear or smell it; nor can we learn it, as we do temperature, by a mere change in the condition of our nerves of touch. All our dynamical acquaintance with things around us is obtained by the study of mental and spiritual

facts, namely, the found and measurable relations of our acting will-force to force not our own. And this is what is affirmed in the first of our two theorems — My will is my only force-finder.

The pretence of the Matter-and-Must-be teachers, that we find acting force by their newly invented 'muscular sense,' without any more help from volition than we require in the use of our other five senses, is not worth dwelling on. It is quite enough to ask them, How are you, sitting there in doubt about force acting in the wall opposite, to get the doubt solved by your passive muscular sense without putting forth your will-force in action; or how are you to turn bare contact into enquiring pressure?

Let me now invite you to place yourself, for argument's sake, with me in the posture of doubt about the existence of this famous matter, which is not acting force in loco, but an inert unchangeable something that occupies space, and is only the seat or vehicle of the force. I ask you neither to affirm nor to deny that it is there, but to be looking with the eyes of sharp sceptics for evidence found by yourself, and to be determined to name and to register exactly what you find, not being imposed upon by assumptions and empty words. The bane of philosophy is the multitude of words, especially general and abstract terms, which stand for no thought.

Suppose that you have before you a small cannon ball, a cob of coal, a piece of oak, and a bundle of wool, all of the same weight, and, therefore, as all agree, containing the same amount of this matter. By pressing them, lifting them, and attacking them with hand or tool, you would convince yourselves of the action of very different forces in the loci or bodies. Further, the force acting in any of them may be greatly varied. Solid mass can be reduced to dust. By rolling the ball on the table, at different speeds, you can

make it a locus of changing and even of dangerous force; and by letting it roll off the table, it will descend with ever accelerated force, so that, while you can stop it after a fall of an inch, it would be unpleasant, at least if it were an 80-pounder, to try that at an inch from the ground. In all these variations of the acting force, the supposed matter in each locus remains unchanged. Think of ice, snow, water, vapour, and steam. Clear notions of force; but what of unchanged matter? Whatever that may be, it is not that force which we find, alter, compare, and remember; the matter may be there, but we have not thus far detected it. We can make theorems about varied force and work done, or between force and heat, but that tells nothing of the matter.

Let us come closer to the question. It is not from bodies in motion that people frame their notions of matter. One man will fancy that he has settled the business by putting a pound weight into your open hand. There it is; feel for yourself. But it is easy to show that the weight of a motionless body is not the matter of it, and that feeling or remembering the weight is not feeling or remembering the matter. Not to speak of the difference in the weights of objects to a diver under water, nor of the effect of a strong magnet held above an iron weight in a scale, it is certain that weight itself alters in the air, while the so-called matter remains the same. If a pound, suspended from a spring balance, is carried up to a sufficient height in the atmosphere, the indicator will show a lessened weight; for, as we all know, weight is nothing but the attraction of the earth's centre of gravity upon the heavy object, attraction which diminishes as the square of the distance increases. Nay, if a pound weight be suspended on a sufficiently delicate spring balance, standing still on this table, it is certain that, if we could read its minutest indications, the weight registered by

the instrument would not be the same for a single hour. The weight of a body at noon is the attraction of the earth upon it, diminished by the nearly opposite attraction of the sun — we may neglect the little moon; but its weight at midnight is the sum of the attractions of the earth and sun towards the same parts. I know not where I have seen it affirmed by men of science, that it is within the competence of mechanical skill to construct a spring balance, that will exhibit to the unassisted eye the increase between noon and night in the gravity of a suspended ton. Thus we see that weight alters, while the supposed matter of the body remains unaltered. In finding or altering, in comparing or remembering the weight of a thing, we are not getting for ourselves evidence or verification of what they call its matter. We are sure, from consciousness and will, of the acting and varying force, because we can find it; and we know it be due just where we find it to the behaviour of the molecules of the locus to the surrounding cosmos; but we are poor doubters if, when finding this force for ourselves in conflict with our will, or with another force like a spring whose indications we have tested and graduated under appeal to our will-force, we allow ourselves to slip into the unproved conclusion, that the force is due to something called matter in the locus. We have not yet found this matter, either within us or without us, and therefore we have no right in rigorous science to talk of it.

Few persons, after all, mistake weight for matter. It is not their encounters with vertical forces like gravitation, but their far more frequent conflicts with horizontal forces, which suggest the notion. It is when a man is pushing before him on the table his lamp, his desk, his tools, or his books, of different sizes, that he is most convinced that he is giving motion to matter, or when he tries to push his table along the floor. It does not often occur to him that he is in

conflict with nothing but the mysterious force called friction. The truth is, that if all friction could be destroyed between the perfectly horizontal surfaces, a puff would send everything off the table, and a blow with a cambric handkerchief would set the table spinning across the room; for vertical gravity cannot at all counteract horizontal motion. When you strike the marble mantel-piece, you may feel certain that matter is there; yet you have merely attacked that infinitesimally fine film of molecules at the surface, which has yielded, it may be, a millionth of a hair's breadth, and come back with speed beyond conception in recoil. I say you have attacked that film; I do not say you have come into actual contact with it, for it is believed that the repulsions acting at close quarters make such contact impossible.

When you hold a nut or a bullet between your finger and thumb, you may think you are finding matter; but you are simply encountering a resistance acting in the locus called nut or bullet, a force which is finite and can be made to yield by pressure; and every one can see that, if no force at all was in action there against his will, his finger and thumb would meet, in spite of the supposed matter between them. In all this, I take it for granted that you are too good a doubter to allow your eyes to settle either the question, What is? or What is manifested?

Here let me show you what Boscovich considers to be the nature of cohesion in solid bodies. Let A and B be two molecules in cohesion. Nobody supposes that they are really in contact. Let them be a billionth of an inch apart—a vast distance, probably, compared with some intervals of cohesion. Boscovich never talks of a single force-point, or particle, but always of their behaviour to each other. He supposes that if A were at a little greater distance from B than A B the interval of cohesion, A and B must, by one of God's laws, attract each other; and that if the distance between

them were less than A B, they must by another law repel each other; but that A B is the exact distance at which they neither attract nor repel, till disturbed by some force. Probably, when no unusual force acts, they are in a state of vibration across the limits of A B, which neither can pass without being compelled by God's imposed law to return. The forces and the speed are of course utterly beyond conception. I could show that a force-function can be written varying from attraction to repulsion, according to the interval between the particles or force-points, of which our gravitation formula may be seen to be a truncated fragment, *i. e.*, which becomes our formula when quantities that vanish before our vast cosmic measures are neglected. And for anything we know, there may be, in the last hair's breadth of separation between the bodies, thousands, nay millions, of points where the force passes through zero, from positive to negative, or from attraction to repulsion, and *vice-versa*.

We have good reason for believing that, if two bricks or two particles could be carried away into outer empty space, beyond the reach of all force from other bodies, and there simply placed more than four thousand miles asunder, they would attract each other, and approach in a right line, by a law of God's force known to us. But no man can tell us how they would behave if placed one inch or a hundred miles asunder. For we can make no free experiment on the force of gravitation without taking the earth's centre of gravity for one of our particles, four thousand miles away from us. There is assuredly a near distance at which gravitation between two particles vanishes, and becomes repulsion at closer approach. And I doubt not that there is a very vast distance where the like change occurs, and the law of acting force is altered, we know not into what law.

Without the help of so-called matter, we can form

consistent conceptions of the manifestation of Divine energy in pure force-points. If a right line C D revolves in a plane about its centre, C and D describe a circle; and if the circle revolves about one of its diameters, C and D move on the surface of a sphere, being always at opposite ends of some diameter of the sphere. We may conceive the rotations to be such that billions of spirals shall cover the sphere in a second, without repeating themselves in the time *t*. Instead of a right line C D, let us think of two force-points, C and D, immeasurably near to each other in cohesion. As five hundred billions of wavelets of light strike the velvet of my retina in every second, we must take high velocities of rotation. Take them at something between a sextillion and an octillion in a second. The question, How? we can no more answer than the matter-doctors. We imagine thus a spherical locus of force, at every conceivable point of which one of the force-points C and D will be present, and exchanging energy with the rest of the cosmos millions of times in every millionth of a second. Do you think that the sharpest John Tyndall up among the archangels, if he got that into his microscope, or could feel it on his wise tongue, could distinguish it from a round shot of solid matter? Yet it would be simply two of God's force-points, having changing position but no parts. I say we do not want their matter to help our poor endeavours to think on this awful border between science and adoring faith. We can make our own round atoms if we need them; but who knows that the fundamental forms are spherical? They may be in molecules, as well as in the grandest sidereal groupings, polyacrons, both plane and solid, whose edges are distances of cohesion of Boscovich, modified by the mutual action of non-collateral summits.

I trust that you see with me, that a doubt about this

matter, which is not space, nor force, nor motion, may reasonably rest in the mind of an exacting sceptic, after all the experiments in his power. And that doubt, when planted, has a wholesome habit of growth; for there is nothing of dreamy metaphysic or absurdity in the notions of Boscovich. The materialists can neither find their matter nor describe it, except as a locus of force; nor their ether. For both *atom* and *ether* stand in their heads for something-sticking-together-by-force.

To me it appears that, while speculations like those of Berkeley and Kant have from thousands of years ago done good service against the superstition of Duality, which set Matter against God, their extravagance has produced a reaction in favour of the reality of so-called matter. It is commonly remarked that Berkeley is unanswerable; and it is as commonly added, "No matter 't is what Berkeley said." It is not a wholesome state of thought, which treats as folly the acceptance of confessed demonstration. That is a Vatican suicide of reason. It becomes me to speak in tone subdued of the logic of Berkeley; but I can never cease to regret that he appears to have missed, or rather to have ignored, that radical dichotomy of thought into active and passive consciousness, from which I hold that all our real knowledge springs. He begins from the first to deal in the same breath with the ideas of temperature and of hardness, as if the will-force had no more to do with one than with the other.

In his Belfast *Address*, Professor Tyndall has reproduced the oversight of Berkeley, in treating touch with volition and pressure exactly like involuntary sight and smell. After showing that mere vision gives no demonstration that you are there, he adds, "And if I urge that I can check my sight of you by touching you, the retort would be, that I am equally transgressing the limits of fact; for what I am

really conscious of is, that the nerves of my hand have undergone a change. All that we hear, and see, and touch, and taste, and smell are, it would be urged, mere variations of our own condition, beyond which, even to the extent of a hair's breadth, we cannot go." He means that this is correctly urged against the witness of the hand and will; but if you can trust your own consciousness more than a dogma of doctors, you know the difference between the witness for an external world of your passive "I am," when without volition, or against your will, you merely smell musk or tobacco, and the louder witness of your active "I am and I will," when at your free choice, and as long and as often as you please, you touch with more or less pressure of acting will-force. Professor Tyndall speaks as if no such difference between those witnesses of passive and active consciousness existed. And they all affect in the same way to ignore the dreaded difficulty of free-will. But is that science?

The just repugnance felt against Berkeley's theory seems to me to arise from its abolishing the reality of space and force and motion, as much as that of so-called matter. Kant, observing this, went on to abolish that of time also; and without a syllable of proof, besides empty dogmatism about *Must-be* and Being *per se*, he decreed that time and space are in themselves, and out of us, nothing real at all, both being but forms of our intuitions.

The metaphysicians will shriek and threaten if I touch either of their grand arcana, Form and Substance. I can stand the storm. For their trope, Substance, in any proposition which they call scientific, even in Spinoza's formidable array of long-winded Definitions, Axioms, and Lemmas, I feel as much reverence as for the Hindoo tortoise which supports the elephant; and for their trope, Form, in such a theorem as this of Kant, I have as much admiration as for the trick of a wonderful conjuror. I think it was a poor

winding up of rigorous science, on that shadowy figure of a bobbin, Form. I have had my finger in those two metaphysical mud-pies in the second page after the Introduction to Kant's *Kritik*, the definitions of the Matter and Form of a phenomenon; but we have not time here to admire their circularity. I dismiss the rhetoric in that monosyllable, and require the meaning. Form means nothing but a definite arrangement of points, whether closed or not closed, in space. Our intuitions are affirmed to be real, and their form, if belonging to them, whatever it may be, is as real as they. Space in itself, says Kant, like time, is purely ideal, that is, unreal, because it is only a form of our intuitions; that is, without the trope *form*, space is in itself unreal, because it is nothing but the real defined space of our real intuitions! With that mortar and that shell, manufactured by himself out of space, Kant blew time and space out of creation! And wonderful it is to me to see profound philosophers going about with that cobweb on their brains. They are welcome to their retort that I cannot understand it. Maybe that great understander the tortoise can.

We are agreed about what we mean by space, the found position of force, found by our will-action, our answer to the question of memory, Where found? With pure space, in which no force is acting, we do not trouble ourselves, because however learnedly we may talk about it in empty words, we can neither find it nor imagine ourselves finding it. The space of Geometry is not of necessity empty space; at least we are there with our rule and compasses.

I have frequently used the words *find* and *found*. If I talk of finding myself, my consciousness, my will or my will-force, I am speaking rhetorically; but when I speak of finding space, form, or force not my own, I use no figure. And it is always finding by inference and with demonstration

that I mean, when that which is found is not-myself. I admit no finding of a Not-me by intuition or by instinct in my philosophy. Intuition and instinct are too vague for me, however convenient for others.

The question I put to you is a definite one. Whether do you prefer to begin your account of what is going on in this cosmos with the pure force-points of Boscovich, in which the will of the living God is energising with perfection adorable of science, as well as with a purpose of progress and unfolding for all, or with the blindly driven and nondescript atoms of the Matter-and-Must-be school, — atoms infinitely hard and impenetrable, of something which is not force,—atoms of marvellous mathematical attainments, and even, as a now jubilant section of that school maintains, necessary and eternal, — atoms whose dimensions in inches are expressed by a decimal beginning with a line of zeros that will perhaps gird the sun, or can at least be neatly written out between this and Aldebaran, — atoms of matter endowed with that "promise and potency of every form and quality of life," which that sharp-eyed observer, Professor Tyndall, can verily discern in them.

Before you make up your minds on the question, it will be only fair to consider what reply the Matter-and-Must-be doctors can make to my arguments. I say, as a man of science, that I know of none in the world but two: one is a "must-be," the other is a vicious circle. Give them all the weight you can.

First, they say, there must be matter where there is force: matter must be the seat, the vehicle, the subject of all force. I want none of their tropes of subject or seat. I know and remember in what place and measure I find acting force. I can define force without matter, and in that definition tell them as much as they can find or tell to me. I say that force, of which I have a clear notion, is any found resistance

to my exerted will-force, which is verifiable and measurable by my will at my pleasure in active consciousness. That is the closest definition of force, quite free from ambiguity, to myself in consciousness; a remoter definition, which is found sufficiently clear for *myself and others*, is that given in dynamical treatises, "that which occasions motion." There is no mention of matter in the mathematics of the subject. What is called mass in formulæ is simply a number which has to be determined by observations of acting force, and is referred to a unit chosen only by use of our will-force. If a brick falls on my head, or a sword enters my body, I receive a sudden pain and injury; but it is not from such events that I get my notion of acting measurable force. It is by the deliberate challenge and encounter of my will that I learn it. With these doctors, it is a principle in their books that no immaterial force is to be confessed or admitted. In a word, their dogma is, that all the force of which science can discourse must act from matter, in matter, and upon matter. This must be, must be, must be so! It cannot possibly be otherwise! Matter *must be* the condition of force.

Of course, that sort of logic deserves every attention from every—broom. Instead of that I stretch out both my hands, and offer to believe it all, if they will show me how to find this matter. Am I to swallow their dogma blindfold? I will see them all canonised first. I don't know matter from catter. They only sing on, "must-be," or talk of "law," which is often their fine word for "must-be." They have nothing more to say. Against that, I place in the scale one little fact. I raise my arm. What sent it up, and what keeps it there? Not force from matter upon matter; but force acting from my will on what they call matter. I can predict how long it shall be up, and fulfil the prediction. I put the knob of my cane into your hand. I push; you push; we push gently; we push hard. And we can predict

our pushes, and fulfil our predictions. The arms and cane are the locus of varying force, varying at our pleasure, beginning and ending at our choice, as we push, resist, or yield by our free will. Is that—so beginning and ceasing, so predicted and fulfilled by us—all force acting from matter upon matter by their eternal invariable laws? Is it not will against will, and from will upon will, in both initiation and duration of the force? Why is the cane thus moved? Because we will. When and how long? Just as we will.

Is my will matter? Is your will matter? Compare their dogma with our little experiment. They will have it that no force can act but from matter upon matter by eternal laws. We exhibit to them evident measurable force, which we know and can prove by accurate prediction to be acting purely from will upon will. Is, then, my will and your will matter?

To this they are compelled to answer; but they do not like it. From that bit of fact and logic they turn away: they say imploringly to fact and logic—take any shape but that! They protest—like so many Cardinals—that all that has been debated and settled for ever long ago; they are quite tired of that! But, forced at last to feel ashamed of shouting must-be, they betake themselves to their final and grandest display of tactics, by an assault on my citadel, my will.

They assure me, in tones of persuasive kindness, that I am under a sad delusion about my will; that it never is a real cause of measurable action or force; that it is purely an emotion which accompanies my movements, all made under compulsion from absolute must-be. They tell me they have studied the forces of the cosmos, and particularly those vital forces of protoplasm which generate what I fancy to be my free-will. They say, How could we understand the correlations of material forces with life and mind; how could we

"discern in that matter," "the promise and the potency of every form and quality of life," if we could not scientifically deduce from it the quality in you which you and we alike call will? Your will is a necessary effect and resultant of the forces which we find, and into which we have deeply searched. We know your will and its genesis better than you do, and all our knowledge of it is deduced from our science of the forces acting in and upon you. You would know this also if you had our learning; and you would be able to demonstrate your will up to the present moment from matter and must-be, just as we can. That is what they say with great perspicuity to me; and I cannot have the rudeness to contradict them.

But, you see, I have not got their learning, and I am afraid I am a sad infidel about their living and feeling protoplasm. What can be done? Well, let us hazard a supposition. If it be not too presumptuous, let me beg you to suppose that, after sitting long enough at the feet of these gentlemen, I came to know about myself, the genesis of my will, and the correlations of force, all that they know. In that case, you understand, I could write down all my knowledge scientifically. Let me begin with an exact date. As we have already satisfied ourselves, the first proposition at the head of my train of reasoned thought about these acting forces would be this affirmation of my active consciousness: When beginning this enquiry, *I willed, and I knew that I willed.* There is no other philosophical beginning about found or sought force. That we have before quite settled. Out of that would logically follow the whole process of observation of the laws of the cosmos, with deductions from the past, full of their differentiation and integration, about acting forces, a chain of demonstration up to the exact date, ending triumphantly with the conclusion from their action, *ergo*, at that date *I willed, and I knew that I willed.* The final proposition is identical with the first; it is that most

laughable achievement in logic, a circle! A donkey's circle, gentlemen! Don't say vicious; let them be all good donkeys. "Speak, ye that ride on white asses," in all the pomp of philosophy round that fashionable ring of evolution, your journey at every footstep ending, like Johnny Gilpin's, exactly where it began; Speak! Will you try to answer fairly this easy *reductio ad absurdum* of the most vital theorem of your science, that my free-will is not my only finder of force, but a found resultant of force? Not one of them will reply. It is far pleasanter and easier to jog on, singing—Must be so! We know! Gee ho! Must be so! What a treat it would be, if Dr. Tyndall, who has startled us so greatly, would for a few minutes dismount, and face this trifle of logic. I fear he will not, unless I throw away a hundred pounds on printers and reviewers of a book on the subject, which no man will buy. Be it so. We shall always be happy to hear his voice; on his own topics there is none like it. We all join in the poet's wish—

> And when John Tyndall rides again,
> May we be there to see!

Much has been written of late on that great man, Dr. Priestley. I can admire his genius apart from his necessarianism. His demonstration that I have no free-will has been recently applauded as equally brief and unanswerable. It runs thus: a will undetermined is an effect without a cause, which is an absurdity. It is short, but long enough to be a blundering sophism. Implicitly it affirms to me two things, if I am to be treated as a verifying thinker—one true, the other false. The true thing is, that I can find effects which have causes; I grant it; I can find them in plenty within and without me. The false thing is, that I can find my will among those found effects. I know of no effects, distinct from logical conclusions, besides the effects of force

and will; and my will is my only instrument for finding either. Could Priestley, when he was carving his goose, carve his carving-knife? No more can you find your own finder, when finding by your will the effects of force and will not your own. All attempts to deduce my will as an effect and a resultant of found forces are either the prate and brag of *must-be*, or a ridiculous circle. My will has a cause; not any nor the whole of these found forces; but the Infinite Mind and Will—the Living God, to whom I am directly and immediately indebted and accountable for my use of life and will. But that is neither scientific solution nor scientific information. The *how*, in this causation, is a question which the true science of the finite has neither the wish to ask nor the power to answer. She has no scale for soul-relations of finite to infinite. There is a sham science, which talks grandly about "correlation of material force" with life and will; but she has never given us therewith a hint of what she knows or means, beyond the statement of vulgar and discontinuous sequences, labelled with a fine word in—*ation*.

All this I have ventured to say, by way of fuller discussion of the first question which I put to myself at the starting point, "I am and I will." In defending my rejection of mere assumptions, I have been compelled to consider the materialist dogma about will. I may seem prolix to some; but the topic really demands more space. Let me hope that my thoughts have been uttered with clearness sufficient to be of value to younger thinkers, who have the courage to doubt the infallibility of the must-be Vatican, now crowing so loud and shrill.

The second question that I proposed to myself in my previous paper was this:—Can I find without assumption any conscious thinker besides myself? To some that may appear trifling. But I was not seeking the genesis of our

mutual certainty of each other's thought, which has not been *built* up from the sceptical position. I was desirous of *showing*, without prate about social instinct, that there is no mode of proving the truth to an opponent at that standpoint, say to a being of another race who allowed my conscious thought but doubted yours, which does not evince with far greater force, that this cosmos is a demonstration of an infinite Consciousness and Will.

I think now that, after my demonstration of a real cosmos of force acting in greater and smaller loci, my second question would have better been, for scientific method, this:—Can I find or prove from what I find without assumption that there is a finite maximum or a finite minimum force-locus?

It is easy to show that the affirmation of a finite maximum force-locus cannot be maintained, by the familiar argument which reduces to absurdity the assertion of a limit to space. None of our materialists, so far as I know, pretend that there is a limit to their universe of matter and force. Yet, if one of them took the fancy of setting up the dogma of such a limit, he would make heaps of disciples among the cultivators of matter-and-must-be logic. Imagine yourself reasoning with such a gentleman, and showing him the nonsense of his dogma, by supposing, as is usual and quite fair, that you were at the pretended limit, and struck it with your stick, proceeding with the usual argument. He would put you to the rout by one word: he would merely have to cry out — knobstickomorphism, knobstickomorphism! and all his admiring crowd would be ravished by the grand new term; they would see in a moment the crushing confutation in it, and would clap their hands with all the triumph of philosophers.

Of a finite minimum force-locus, an absolute indivisible minimum body, our matter-and-must-be friends are fanatical assertors. They must have their primal solid atom. To

them life and death hang upon that. If I had not a word of my previous arguments against matter to adduce, I should have been compelled, in philosophy without assumptions, to reject the whole conception of it, in rejecting this minimum body or force-locus, for this valid reason, that it is an assumption and nothing more. Place in that assumption the limit of minuteness of your atom where you please, I say, I demand a reason why there is not or cannot be an atom of half that size. To this they have no reply; and they are compelled, either to descend with me to the locus absolutely least, the point without parts, or to grind their teeth and groan their prayer to Must-be. "O, Must-be! hear us. O, alma Venus of our Lucretian mysteries, great spawner of our fetishes, and mother of our gods; O, Must-be, hear us!" And they leap and kick upon the altar which they have made, and gash themselves in vain.

Let me beg of you to bear in mind the three scientific reasons for which I doubt, and refuse as a philosopher to grant, the existence of what they call matter.

The first is, that I cannot find it for myself, whilst these doctors either will not or cannot show me how to find it, as distinct from acting force in definite locus of space. The second is, that their affirmation of a necessary bond between their dead matter and force is a contradiction to the perpetual witness of my active consciousness. The third is, that, in the account of this matter in which they all agree, there is an unproved and unproveable assumption in their assertion of a finite minimum locus of force. Any one of these reasons would compel us to cast out, as utterly unscientific, their notion of the pretended matter from a philosophy without assumptions. Then, if we add this consideration, that they can lay down in terms of their dead and solid atoms nothing that they either know or desire to know about the cosmos, which cannot be stated as well in terms of the force-points of

Boscovich, we are driven to the conclusion that matter, like must-be, is a term too many; that matter, like must-be, is a symbol, not of thought, but of the want of thought; that matter, like must-be, is an instrument of sophism; that matter, like must-be, is a venerable rag of Ignorance.

There was a time, less than four centuries ago, when the new doctrine, that there is no solid crystal firmament arching over the immoveable earth, excited far more angry disdain and incredulity among both learned and unlearned, among all but one in millions, than the teaching of Boscovich, that there are no solid atoms of matter, has ever yet aroused. That firmament was shivered into smoke invisible by shots of thought through the telescopes; and our modern atheists are trembling to behold, how the truth revealed by their microscopes and spectroscopes is consuming the old dust of their eternal cause, and leaving behind nothing but the force and the science of the Living and Working God.

That it is so is clear from this, that they have had to manufacture an ether in which to float their atoms, the ether having an advantage over matter in being a word of five letters only; and that now they are dressing up a new definition of their matter, not yet come out. I hope, Sir, we may be invited to the first ball, and make our best bow to the young beauty and her chaperon.

Here, while speaking of maxima and minima, we may amuse ouselves for a minute or two with the queer dogma of the extreme left of the Matter-and-Must-be school, the deniers of a conscious and intelligent Cause of the Universe. Their dogma is, that there exists somewhere a maximum brain, a maximum finite intelligence, or else a round table of them. They yell out their derision of my absurd anthropomorphism if I confess my faith in God, the Infinite Mind and Will, while they expect me to admire vastly their correct anthropomorphism just up to a highest finite mind. They mock at

me as a man-magnifier. But which is the most like a magnified man—their asserted biggest biologist and topmost protoplastologist, or the spiritual object of my worship, without parts or passions? These atheists, not we, are the grovelling self-magnifying anthropomorphists. Do they deny that they assert this highest finite? I will compel them to confess it. They allow that there are minds of lower and higher powers; nor do I believe that there is more than one among them who imagines himself to be the crowing pinnacle of all existing intellect and personality. From their own confession, it must follow, and it does follow even to them, that, as there is no infinite mind, there is somewhere a maximum finite intelligence, or else a round table of such persons, all of equal brains. That is their own precise dogma, wherever they be, from morn till dewy eve.

It is not disrespectful to them to imagine that this asserted maximized finite philosopher should be found out by them, and should learn in his far-off star enough of the fame, say of Dr. Mustbeso, to pay him a visit down here, as a friend and brother; nor can it offend one of you if I suppose that you had the good fortune to be introduced by the Doctor to their loftiest protistoplastologist in all the cosmos. I think I know what you would say to that sublime person if you got him aside for a moment. You would say—"I don't believe, nor do I think that you believe, what Dr. Mustbeso tells me. He says that he knows, and that you know, that you are the most exalted intelligence in all the universe." He would, of course, reply—Did he say that? Then get your friend the doctor without a moment's delay into safe custody.

There is one gentleman whom you are to except from the sweep of these remarks on the atheistic anthropomorphists. This is Mr. Matthew Arnold, who, in his *Literature and Dogma*, has derided the belief in a personal God, the True

yet Unrevealable "I am that I am," or in any conscious intelligent Cause or Ruler of this All. He has done more, and what gives me the right to name him here. In the *Contemporary Review* for October last, he has written as follows:—"In general, as God is said to have made man in his own image, the image of God, man has returned the compliment, and outwardly or inwardly has made God in the image of man." There you have the coarse and vulgar charge of anthropomorphism; and a fair and honest account you see it is of your faith and mine. He goes on:—"So we construct a magnified and universal man, by dropping out all that in man seems a source of weakness, and inserting the contrary." "Then, between the magnified man and ourselves we put, if we please, angels, or men etherialised. The objection to the magnified man and to man etherialised are one and the same. We absolutely have no experience whatever either of the one or of the other." Observe, by the bye, that this objection is equally valid against both the conceptions and the names of zero and infinite in space or quantity; for of pure nothing and of actual infinitude, "we have absolutely no experience whatever." If Mr. Arnold insisted upon it, that when you deny the possibility of a maximum finite number of feet, or of a maximum finite volume of space, and thereby assert the infinite, you are merely constructing a magnified human stature, or a bloated human skin, you would remark that he stated for truth just a flat untruth; yet that untruth is quite as true as what he chooses to affirm about your constructing for your God a magnified man.

Let us turn over without violence or strain what he has laid down. Of course, his magnified man is not magnified in feet and inches; it stands for a being finite or infinite, divine or angelic, conceived by us as exalted beyond known man in the attributes of conscious intelligence. He says, "The objection to the magnified man and to man etherialised

are one and the same." The objection is without reserve against all that is not known to our experience. Beyond what is so known to us, if we form the conception of a greater mind in any part of the universe, we do a thing objectionable, for this plain reason, that we have absolutely no experience whatever of a man so magnified or etherialised. Yet, if Mr. Matthew Arnold were here, he would probably allow that in mental power there has been a progress of humanity. One of you might reasonably ask him — Suppose the case of a Matthew six thousand years ago, distinguished as it were, like you, above all his race then living for sweetness and light, for logic and modesty: suppose that, by the mental process of Matthew-morphism, he had worked himself into the belief that there might be then somewhere in the universe a wiser and more etherial Matthew, far far above himself, just such a Matthew as you actually are at this moment: should we have a right, if we came to know what he then did, to say that it was objectionable? He must reply, Certainly not; for we cannot affirm this Matthew present to be beyond our experience. You might seek farther light at the fountain thus: — Suppose that I, after forming a duly exalted conception of what you are, should Matthew-magnify that into the belief that there is somewhere in the cosmos one nearly twice as etherial as you for sweetness and light, one perhaps twice as great in literature and dogma: would that be a thing objectionable? Assuredly it would, quoth he; for we have absolutely no experience whatever of a Matthew so magnified or etherialised.

I should like to get a sight of that Matthew. After my last long look at him, I should go away, saying to myself, In what a blessed state of mind must that gentleman always wake, and always resign his sweetness and his light to slumber! And when he walks abroad, does he not hear in

the applauding rustle of the waving trees the echo of his thought—

"O fortunatam! natam me" culmine terram?

In Philosophy without Assumptions, we can no more submit our common sense, and our right to doubt and to demand a reason why, to the atheistic dogma that there is a maximum finite conscious mind and will, than to the materialistic dogma that there is a finite minimum atom or force-locus. Both dogmas are unproved assumptions, capable of no defence whatever, besides flat untruths and beggarly rags of *must-be's*.

Upon the question whether there be a minimum locus of consciousness and finite will, I am not competent to enter. I cannot attempt to state the question without begging your pardon for the trope locus. Let me make this plea, that I do not as these must-be philosophers do, stick tropes like *form* and *substance* into fundamental axioms and definitions. I content myself with referring the student of these profound mysteries to what our president, Mr. Mott, has so clearly and forcibly written in his paper "On Force," which formed his opening address to this Society in 1871.

Iadd one remark, thatt he primary division of the Cosmos into the Conscious and Unconscious in our elementary manuals of philosophy is an unproved assumption. How does the scient know, and if he does know, why does he refuse to help me to find it out for myself, that there is absolutely nothing of finite consciousness and will, in addition to the compulsory forces acting, in the minimum force-locus? Professor Tyndall has recently given us mysterious hints about a new or modified definition of matter which is brewing. What can it be? If I might hazard a guess, well-founded upon what I have learned about their protoplasm, I should say that they have prevailed upon their

mother Fish-goddess Must-be to spawn them a span new shoal of atoms, all alive. So we may look out for a double-barrelled philosophy of matter, charged on the left with the old dead atoms of Lucretius, and on the right with the new living ones of the Protoplastologists. It is a funny sort of science, which publishes abroad with flourishing trumpets its grand discoveries and theorems about matter, and then kindly promises us a definition of matter, no man alive knows when.

Some of the doctors adopt a tone of conciliating candour and of great profundity: we hear that the underlying substance of matter and that of mind may be at the bottom the same, "made of the same stuff": we hear that the phenomena of matter can be expounded as phenomena of mind, and *vice versa.* Would these thinkers and knowers kindly help us to their thoughts, instead of to a dish of tropes and quarelling words ?. Are phenomena and inferences all one ? Are mind and matter the same, defined and found as identical? If not, the gentlemen have the great advantage of being enigmatical. But, playing at sphinx is not talking science. I say to all and each of them, If you have a confession of faith and adoration to make, make it like an humble and an honest man; but do not pretend, to us ignorant people, that you have a scientific key to chambers which science can neither shut nor open.

Let us, for a conclusion, give a little attention to Professor Tyndall.

In his famous *Address* at Belfast, page 29, the President of the British Association spoke as follows:—"Abandoning all disguise, the confession that I make before you is, that I prolong the vision backward across the boundary of the experimental evidence, and discern in that Matter which we in our ignorance, and notwithstanding our professed reverence for

its Creator, have hitherto covered with opprobrium, the promise and the potency of every form and quality of life." "All religious theories, schemes and systems, which embrace notions of cosmogony, or which otherwise reach into its domain, must, in so far as they do this, submit to the control of science, and relinquish all thought of controlling it."

These words, and many more in the oration, may be expounded in more senses than one. What Professor Tyndall privately understood by them is neither known nor asked by me.

I am not about to comment on this tall talk as uttered in earnest by him, but as words too plainly understood in earnest by an applauding crowd of hearers, editors, and readers, vastly his inferiors in mental power. He knows that it would be a very stupid thing to speak seriously of the control of science over the field even of demonstrated truth. What is the sense, and what is the need, of affirming such control over the multiplication table? And to prate of compelled submission to the control of science over thoughts touching or reaching into the domain of cosmogony, in which not a single scientific question has yet been asked, much less answered, is oratory at the boiling point of nonsense. Professor Tyndall knows that. Yet this is all very proper sense, if for the control of "Science" you put the control of "the Church." Science here stands for that good old word Church, the church of the Mustbeites and Matter-day Saints. And "Church," when brought forward as threatening authority in debate, means always and on every side just this and nothing more — myself, and the gentlemen who talk and brag with me on our essentials. Professor Tyndall felt it to be his duty to the Matter-and-Must-be church to do a little sectarian swagger, knowing that it would all be gospel to the credulous youngsters and scorners of his Epicurean left, and all rank atheism to

the raging priests and parsons opposite. He himself believed what he said, exactly as Dr. Manning did, when some two or three years ago, according to the reports in your admiring papers, he sung out in his own person to my bishop and me from one of your pulpits, "Were you ever in antiquity, or any that belong to you? I was there." The President of the British Association chose to show us that he too could blow a blast on that cracked old clarion of hectoring orthodoxy; that he, as well as any high church bishop or low church dean, could cant out that pagan "*procul este profani*," and that, like a common cardinal or metropolitan, he could put on the grimaces of the hierophant and mystagogue.

This rant of sectarian bounce and mischief must go on on all sides so long as Ignorance is king. I may succeed, perhaps, in saying something that in the minds of those who love to think a little may diminish the mischief.

I say, then, that the wisdom of these matter-and-must-be doctors is over-rated considerably by themselves, and most enormously by the lion-worshipping public. Their perpetual cry is, Law, the Realm of Law, the Reign and Control of Law! They are the learned professors and expounders of natural law, in all the cosmos of force and life. Of course they are, of all the law in action now, from their atoms up to the life I am here living! Does not the President inform us that they can discern in that bare dead matter the promise and the potency of every form and quality of life?

Let me examine their legal attainments in something less than life. Gentlemen of the Board of Cosmogony, have the goodness to state to me the laws which your atoms obey in the familiar changes from ice to steam. Forthwith they are ready with a torrent of words, from refrigeration and solidification, to calorification and vaporisation, with cadences in universality and invariability. I reject their fine words in

-ation, -ality, and -ility, and demand an account of the laws of the acting forces. I tell them, I doubt not the day will come, when some man or angel shall, on dipping his thermometer into the water, be able to assign the magnitudes, distances, vibrations and rotations, under known attractions and repulsions in various lines, of those molecules, and to predict from point to point, and from moment to moment, the continuous changes of their behaviour to each other in the rising temperature from ice to steam, and back again from invisible steam to snow and solid ice. Can you give us one hint about all this? Can you answer or can you frame one sensible analytic question on the energy and continuous variation of those laws of force not vital? They know about as well how to do that as the geese of their tailors. I ask them, Can you state the laws of the resistance, from point to point, which an oar of given shape, at work under given force, encounters in the flowing, or even in the calm water? They cannot. Can you tell me the acting law of the pressures and resistances all round, which a bird or even a ball flying encounters in the stillest atmosphere of given density and temperature? They cannot. I give them their choice of any cubical quarter inch of force-locus, animate or inanimate, in air or earth or sea, and any moment of time they may select; if they can give a scientific statement of the continuous behaviour due to the acting forces of any three masses or force-points in that space, for one minute preceding and following, I will recant all that I have uttered. For a true and exact expression of any law of force acting at one of God's force-points, besides gravitation, these jurisconsults of nature must wait for the teaching of another Newton. A list of empirical and discontinuous sequences is not a known and working law.

But you may remark that it is into the forms and qualities of all life, that is of the vital forces of matter as

they call them, that these gentlemen claim to have so much insight. Now do you believe, that men so ignorant of the definite laws of what they call inorganic forces, are any wiser on those of the forces at work in my finger, or my finger-nail, or in one of my hairs, or in the hair of a seedling nettle, at any point from the tip to the root of it, or that they can tell us anything scientific at all of the way in which the fabric is put together, or fastened where it stands?

I wish I had the space to give you the result of my endeavours to find out something of what they know and can define, from some of their best physiological and histological manuals, written for the reading of younger and weaker heads than mine. I could tell to any student of the laws of life a merry tale about that "beggarly account of empty boxes." I should be glad of an opportunity of showing to you what I have learned of their discoveries with their microscopes, their vivisections, and their teasing needles, about cells and morphological elements, and what they choose to call protoplasm—(I wish I had time to show you over the comical chaos of their definitions)—in the morsels which they cut away from every part of living, dying, and putrefying bodies, yet all alive, alive—o! For, many hours, nay days after, when we have pickled and preserved it, when we have pumped into it our gases, acids, and steam, when we have boiled it in vinegar, and hardened it for fine slicing in a freezing mixture, and teased it and torn it, we can see, we can, that the particles and nucleolus of protoplasm are living and feeling, yea, whether they move on our heated stands or not; because—must be so! we know! And when we get our microscopes up to 500 more linear power, we shall catch the migratory cells in the act of conjugation, and complete our theory of cell-genesis! There is daring enthusiasm of superstition in what they do, and

abundance of cruelty, but not a glimmer visible to me of any deduction, nor even of scientific conception of law. Then these prophets of torture and mortal agony, these apostles of death and corruption, meet all smiling, with such elegant bows and compliments to each other, as Professors of Biology and the Laws of Life, that it is quite a lesson in deportment, most improving to us all!

The grandest of all their grand words, when they talk law, are Differentiation and Integration. They have finely discovered that the cell, the oak, and the whale are "gradually differentiated" out of the endochrome, the acorn, and the embryo. That shows, you see, the infinitesimal exactness of their knowledge; you find it in many of their books, I think in most of them, and plenty of it. When Topsy was asked by her catechist, "Who made you, Topsy?" she replied, "I never was made. I 'specs I growed." If that bright young lady had answered thus — "I 'specs I was differentiated," she would have delivered one of the grandest lessons of biology on the law of vital processes. And if, when next catechised, she had replied, "I 'specs I was integrated," she would have delivered the same lesson in more learned style, framing and uttering, with those two words in *-ation*, every jot and tittle of the scientific conception of the origin and laws of living growth, in the heads of the professors, for which they stand.

Let me take care, as I may have to answer for all this, not to misrepresent these gentlemen. I will read to you three passages from Professor Tyndall's Belfast oration. At page 21 he says, speaking not so much for himself as for the Biologists: "Nor can we fail to discern what vast modifications may be produced by natural selection in periods sufficiently long. Each individual increment may resemble what mathematicians call 'a differential' (a quantity infinitesimally small); but definite and great changes may obvi-

ously be produced by integration of these infinitesimal quantities, through practically infinite time." At page 29 he says, speaking evidently of the period preceding the evolution of life, that he himself discerns, "in that matter," "the promise and the potency of every form and quality of life." And at page 30 he says, "It is by the operation of an insoluble mystery that life is evolved, species differentiated, and mind unfolded." I read this third bit once more, for there is no telling what some of you may come to; and you ought to study beforehand this dignified presidential circumlocution for that unbecoming word, *ignoramus*. I fancy that he means us to gather that he is quite beaten by the question, How did matter first come to life? He gives it up, doubtless to the disgust of his scoffing left, as "an insoluble mystery." But it is evident that he knows a deal, at first or second hand somehow, about the *operation* of the mystery. For if he had known nothing at all about it, what right would he have had, in that chair of science, to stick that word in *-ation* into the predicate of his profound and original theory of human ignorance? Can "the operation" be the new spawning of atoms? It is evident, also, that the Professor, or somebody known to him, has skill in "the differentiation of species," and, we may presume, of many other functions of the insoluble mystery. But can any of you make out why it should be quite insoluble to a mind able to discern in that previous matter the promise and the potency of every form and quality of life? One wonders no less why it should be insoluble to one who knows, in mathematical phrases, what he means by the *operation* of the mystery, and who "cannot fail to discern," from the first and simplest living things, "the definite and great changes" which "may obviously be produced" by differentiation and integration!

When mathematicians talk of differentials and of results

of integration, they have before them, under even their symbols of number, an expression of quantity, whose scientific law of growth is exactly given to them, so that they can form its values for themselves, from 1, 2, 3 in the scale upwards through the finest shades of difference, and are able to answer, about its minutest changes of value, every question How or Why that they require to ask. This given scientific law of growth is precisely what the biologists never have before them, nor can conceive, in their tall differentiation-and-integration talk. This is really true, however hard not a few readers may find it to believe, about preachers so much admired for their words in *-ation*.

I know that my tone will sound to unscientific ears as almost outrageous to the doctors; but it will only be fair in them to enquire of the mathematicians about their established use of their weightiest words. Mathematicians only can estimate and enjoy the value in law-learning of this allusion to them by the President.

But the picture on the whole, I think, is enjoyable by all, in the contrast between Professor Tyndall's frank confession of the utter ignorance of science about the origin and evolution of life and mind,—a confession in which we all join, although we do not presume to express our shallower *ignoramus* in terms so stupendously wise and philosophical,—and the amplitude of the claims which these Matter-and-Must-be doctors contrive, not only to set up, but to get accepted by thousands of educated Englishmen, of profound biological learning about Life and Law. Pray do not, as you look at the picture, say anything rude about Matter-and-Must-be Biology, nor call it all Topsy-philosophy; for that would be too bad, too bad!—I do not mean upon the Biologists, but upon Topsy.

Whatever can it be, then, that these gentlemen mean by their ceaseless prophesyings about the Reign of Law? They

mean two things, one a vulgar truism, the other a prudent euphemism. The truism is that there is law, that the cosmos is not lawless, that there is order and regular sequence, which can be noted,

> "Till old experience do attain
> To something like prophetic strain."

But every henwife knows this truism. She can predict the sequence from egg to chicken, from chicken to pullet, from pullet to sitting hen. She is quite clear about the bond between feeding and fattening, or poisoning and killing, although she never talks about "correlation," nor "assimilation," nor dogmatises with "universality" and "invariability." The anatomist and histologist knows more terms of the sequence; he torments more Latin and Greek words; he makes and throws away more blundering guesses. But is he at any point of the sequence more competent than she is to define the laws of force which the changes and motions obey from point to point, and from instant to instant? In calling a process of work which is inconceivable to them by the name, crystallisation, fermentation, germination, or cicatrisation, do they fancy that they have thrown a ray of light, either on the changes and steps going on at close quarters, or on the laws of forces in action on molecules? Of those actual processes and laws they know about as much as the screws of their microscopes.

Next, the word law in their mouths is a prudent euphemism. It is "law" for "must-be." That is their notion! Their great men dearly love to be spounding and splaining of "necessary law:" and what is that? Just must-be law! Some of them try to avoid *must*, and to do it with *cannot* and *impossible*. It is all the same dogmatism. If you have anything to say to me in science about demonstrated law, imparting your demonstrations, I will listen with all reve-

rence. But *must-be* law, though laid down with "can't be" and *-ality* and *-ility*, is always in the mouth of the propounder, Our law, and My law! Their *can't be*, if unchecked, may turn into a terrible *sha'n't be*. That sort of logic I refer, not to my head, but to my foot. Nine-tenths and more of what these gentlemen mean by their most solemn pronunciation of the word "law" is Must-be so! We know! And if we contradict their Must-be's,—as we ever shall sternly contradict them, even when their dogmatism is loudest, on that boundary where truthful and modest science commits us to the higher teaching of conscience and of faith,—they roar and rail at us for denying, as they most falsely pretend, the control of law! It appears to me, on the whole, Sir, that the patronage of the cosmogony department is, to say but little, rather queerly administered.

If now these Matter-and-Must-be doctors are not cosmic lawyers, what are they? In the first place, they are noble museum-makers. No praise of tongues more eloquent than mine can cover their deserts in the toilsome collection, not of profit for themselves, but of imperishable wealth for all, in their patient researches, and their masterly arrangements of what they find, whether facts of experiment or of structure. What a wondrous treasure-house it is of Divine Revelation, where we obtain our most intimate and instructive glimpses, not of the Unrevealable as to Himself, but of God here and now Revealed outwardly to us; the treasure-house which they are ever filling, not only in glorious rooms and ravishing cabinets, but far more in the scientific memoirs and costly engravings laid up in the libraries! What if it be all little more than a skilful array of isolated facts? They are facts which can never become trivial or forgotten; facts, the connexion of which the Newtons among men and angels ponder and will ponder—with deep question asked and answered, with deeper question asked and answered, and with still

deeper questions asked and yet unanswered—for ever and for ever!

And what to the student is rich and enriching Museum, to the unlearned who is capable of thought is Spectacle of beauty and glory. The teachers of this material philosophy rank high, in the second place, among the noblest spectacle-makers. What is the costliest splendour of your theatres, though living queens and emperors in all their pomp and pride be there, compared as spectacle with a case even of dead humming birds? What feasts for delighted eyes like those of God's marvellous works wisely arranged, laid bare or truly pictured; or like the sorcery with which Professor Tyndall knows how to enchant the gazing thousands, uplifted all and more or less purified as they gaze, by those manifestations which flash at his command from the dread unknown forces that play around him? We all alike honour the mighty grasp and exquisite delicacy of that master-hand, in the exhibition of those scientific spectacles. Let that be heartily said. But it cannot be quite all praise. Is it not a long way, think you, from museum-making and spectacle-making to the claim of insight into "the power and potency" "in that matter" "of every form and quality of life"? It is not a longer way from museum- and spectacle-making to the control of the domain of cosmogony?

We shall not soon forget the imposing picture of Professor Tyndall at the top of his tall ladder, with the hammer in his awful hand, nailing up that thundering board:—Take notice! All parsons, poets, metaphysicians, and moralists among men or angels, who after this date may desire to meditate or philosophise in the domain of Cosmogony, or in any province thereunto reaching, must submit all that they think, believe, or speak to the control of what I call Science. Given at the Board of Control of Cosmogony, by order of their godships, Matter, and his mother Must-be, and signed, John Tyndall, President.

Nor can we forget that most edifying picture of the same John telling his experience at Meeting there in Belfast, and meekly confessing with closed eyes to the brethren and dear sisters, how he often prolongs the vision backwards across the boundary of the experimental evidence, and discerns in that matter—but Stop, you say—Is not discerning by prolonged vision across a known boundary, in the mouth of a man of science, something like experimental evidence? What other evidence have we of the remoter nebulæ and stars? Ah! you know nothing. It is the *experience* of that blessed John, which has so often prolonged the vision across the boundary of experience; and there he himself has discerned in that matter, millions and millions of years ago, "the promise and the potency of every form and quality of life," from cheese-mites up to Cherubims! Do you believe that

> The sweet little cherub that sits up aloft,
> Keeping watch o'er the life of poor Jack,

had not fun enough in him to send to the celestial *Punch* a playful cartoon or two about his scientific darling?

Ah! Sir, thinking of our dear friend the Vicar of Wakefield, I cannot repress the wish—O for a pencil of a Goldsmith, that I might worthily paint that great Doctor at that fair, conquering Moses, and astonishing all men, with his cosmogony and his spectacles!

POSTSCRIPT.—To the majority of readers, my tone of sarcasm and censure upon an eloquent and popular school of physical philosophers will appear unbecoming and unjust, if not outrageous. I maintain that it is justified by the comparison which I have made between what they know and what they, with so few scruples of bashfulness, pretend to know

about Law, and by the challenge which I have thrown down to them to prove their pretensions. Yet it is due to the reader and to myself to show, that these Matter-and-Must-be doctors have incurred reproof far more severe than anything that can fall from me, who do not pretend to have any skill in their departments of science, from one of their peers, second to none of them in philosophic power and renown. The following extracts are all made from the first part of *Protoplasm, or Matter and Life*, by Lionel S. Beale, M.B., F.R.S.; third edition, 1874:—

"Will any number of such extraordinary assertions as these enable us to explain the movements of a little bit of living matter? Does the law of conservation of energy throw any light whatever upon the cause of the vibration of a single cilium?"—p. 22.

"The physico-chemical school pretends that the phenomena to be observed in a living thing, or bit of living matter, can be explained by known laws; but they do not even attempt to give an account of one of the changes characteristic of any living thing in nature. They cannot imitate the phenomena occurring in the simplest form of living matter." —p. 23.

"It is very strange, but nevertheless true, that those who teach us that '*suns may resolve themselves (!) into floræ and faunæ*' are quite unable to show how a very minute portion of sun becomes 'variously modified,' and resolves itself into a minute particle of living matter, such as a microscopic fungus, a pus-corpuscle, or a cancer-cell, or any other living thing. . . . The formation and destruction of faunæ and floræ, of asteroids and worlds, of suns and systems, are to engage the attention of the fortunate student of these days, not the perturbations of a cell or the oscillations of a bit of living jelly."—p. 41.

"Neither the chemist nor the physicist has taught us

anything concerning the actual changes which take place *when* pabulum becomes totally changed and converted into *living* matter, or when the latter gives rise to some peculiar kind of formed matter."—p. 44.

"Mr. Justice Grove has recently affirmed (*British Medical Journal*, May 29th, 1869, p. 486), that 'in a voltaic battery and its effects' we have 'the nearest approach man has made to experimental organism;' but he does not show us in what particulars the voltaic battery resembles organism. . . . Neither Mr. Justice Grove nor anyone else has yet adduced a single argument to justify a comparison between any living organism and any machine."—pp. 46, 47.

"Tyndall tells us very plainly that 'molecular forces determine the *form* which the solar energy will assume. In the one case, this energy is so *conditioned by its atomic machinery* as to result in the formation of a *cabbage*; in another, it is so *conditioned* as to result in the formation of an *oak*' (*Heat considered as a mode of Motion*, by Dr. Tyndall, 2nd edition). Whole volumes might be written in such style, without conveying any information to the reader's mind. The reader, of course, wants to have interpreted to him what is meant by the 'molecular forces,' and the nature of the act of 'conditioning,' and the character of the 'atomic machinery.'"—p. 52.

"Of late, few terms have obtained such pre-eminence as the word 'molecular.' 'Molecular forces' are supposed to account for some of the most important phenomena of living beings. Molecular physics is the science of living things, and it would seem that those who understand it are enabled to account for every vital action......It unfortunately happens, however, that hitherto no one has been able to define exactly what is to be understood by a 'molecule.'"—p. 58.

Dr. Beale might safely add, that if Dr. Tyndall could get a molecule clearly into the field of a microscope powerful

enough, and had Professor Huxley to help him with his mastering theorem ("fact I know, and law I know"), quoted by Dr. Beale at page 76, they would boil all the "lobster-protoplasm," kill all "the matter of life," and roast every "structural unit" of life in England, before they got hold of the scientific expression of a single one of the numerous laws proper of force in action in and upon the molecule, except the law of gravitation, which a certain mathematician taught them.

"Mr. Huxley maintains that protoplasm may be killed and dried, roasted and boiled, or otherwise altered, and yet remain protoplasm."......"But the statement is incorrect, because in the process of assimilation what was once 'protoplasm' is entirely distintegrated, and is not converted into the new tissue in the form of protoplasm at all."—page 100.

"Correlation is the 'abracadabra' of mechanical biology. ....The phenomena formerly supposed to be due to 'differentiation' are now regarded as the result of correlation. ......But as yet, no operation characteristic of any living being has been explained upon any physical principle......Not the shadow of proof in favour of the analogy supposed to exist between life and other forces has been yet adduced."—p. 72.

The reader will find plenty more of this unmerciful hitting in the charming volume of Dr. Beale. He is a man worth punishing for his presumption. A single proven fact, if the assailed dogmatists could produce one, would turn to nonsense and falsehood his sweeping negations. There is nothing in the wildest inventions of fallible or infallible divines, white, black, red, or brown, more remarkable than the "correlation," "differentiation," "integration," and vivisecting trumpet-logic of Matter-and-Must-be Biology.

ORIENTAL PANTHEISM AND DUALISM.

BY THE REV. W. KENNEDY-MOORE, M.A.

IT is proposed in this Paper to review briefly some systems of thought which have appeared in India, and which have both a philosophical and a religious aspect. The subject may be appropriately introduced by a very rapid survey of Hinduism, and the modifications it has undergone. For we should be greatly mistaken did we imagine this ancient system to have endured, through so long a lapse of centuries, exempt from that law of change which affects all human things. The institutions of the East strike us indeed as steadfast and unaltering, in contrast with the bold and eager enterprise, the feverish energy and revolutionary passions, of Western nations. But rock as well as river must witness to the hand of Time in alteration, however slow.

In the history of Hinduism, three principal stages may be noted. Its primitive condition is brought before us in the four Vedas, the most ancient and sacred of Hindu religious writings. These are said to have been put in their present shape by a sage named Vyâsa, which signifies Arranger. He was probably the great leader in the work, or, as is still more likely, only the personification, of the era and school or schools of Brâhmans by whom the task was accomplished, of gathering up all the fragments of scattered devotional material in use, and embodying them in a permanent form. An examination of the collection shows that the writings included in it could not have been synchronous, but are the product of successive periods, differing appreciably in social condition, religious ceremonial, and even progress of language. Each Veda consists of two parts, the first of which,

called the Sanhitâ, is a collection of hymns or prayers (mantras), and the second, of precepts (brâmanas). The Sanhitâ of the Rig-Veda, the first of the four, is probably the very oldest set of writings in the world, with the single exception of the earlier Hebrew Scriptures. It is composed entirely of devotional odes or hymns, arranged somewhat loosely, according to the authors and subjects. Some of these are probably quite as ancient as the time when the warrior Psalmist ruled in Judah, and breathed forth those inspired lyrics which have thrilled the souls of men to their inmost depths, through every generation, with unabating power. The hymns of ancient Hindu worship, however, wring with other tones than those of David's harp. We miss the nobler elements of spiritual life and insight. Anguish because of sin, and aspirations after nearness to the all-holy Infinite, are equally unknown. The deities to whom they are addressed are simply the more striking and powerful manifestations of external nature—the sun and sky, the winds and flames. These are invoked to bestow their blessings, and withhold their destructive energies; to shine with fostering ray; to send refreshing showers; to grant abundance of all things requisite for the comforts of this mortal human life. The following extract is from a hymn to the sun, translated by Professor Whitney, in a metre like the original. The two proper names are both designations of the luminary:

"This excellent new praise of thee, Oh Pushan, splendid heavenly one! by us is chanted to thy name.

"Do thou enjoy this song of mine; welcome my strength-imploring prayer, as bridegroom welcometh a spouse.

"Who on each creature looks abroad, whose vision comprehends them all, that Pushan our protector be.

"OF SAVITAR, THE HEAVENLY, THAT LONGED-FOR GLORY MAY WE WIN, AND MAY HIMSELF INSPIRE OUR PRAYERS.

"The grace of heavenly Savitar, through our devotion seeking strength, of him the generous we implore.

"To heavenly Savitar, the wise, with well-appointed offerings, pay reverence, by devotion urged."

The sentence printed in capitals is the *Gáyatri*, which is reckoned the holiest verse in the Vedas, and has grown into great use as a liturgical formula of peculiar sanctity.

While the bulk of the ancient Vedic hymns, however, are exponents of simple nature-worship, there are a few that touch on deeper problems. In Goldstucker's translation of one of these occurs the following passage: "Then there was no entity or nonentity; no world, or sky, or aught above it. . . . Other than HIM, nothing existed (which) since (has) been. Who knows exactly, and who shall in this world declare, whence and why this creation took place? The gods are subsequent to the production of this world; then who can know whence it proceeded, or whence this varied world arose, or whether it uphold itself or not. He who, in the highest heaven, is the ruler of this universe, does indeed know; but not another one can possess this knowledge." It has been attempted, from passages like this, to demonstrate that the underlying and real religion of the Vedic hymns is a pure Theism. By establishing such a conclusion, Rammohun Roy hoped in recent times to recal his fellow-countrymen from the follies of idolatry to the adoration of one Supreme Being. Had he proved all he wished, his scheme would none the less have failed in practical effect. But it does not appear that his reading of Vedic belief is correct. There is indeed a deep-seated conviction in the human heart of the Infinite One who rules over all. Amid all the bewilderments of idolatry and negations of cold proud scepticism, this ineradicable belief will sometimes find utterance. Its voice rises in protest against the current accepted faith. But we should err if we concluded hence

that it spoke the essential spirit of the religion it condemned. Looked at in their obvious meaning, the oldest extant hymns of Hinduism show that it had departed from the purity of primeval worship, and become polytheistic through deifying the forces of Nature, although the grosser forms of idolatry were as yet unknown.

We need not touch on the distinctive characteristics of the second, third, and fourth Vedas, except to notice that, in the true spirit of idolatry, the simple rites of earlier times, when the oblations were chiefly of clarified butter and the juice of the asclepias, become developed into a very long and complicated ritual, some forms of sacrifice actually extending over entire days, and requiring vast preparation and a great array of ministrants. The growth of the sacerdotal element naturally keeps pace with this, and the Brâhman becomes more distinctly the priest. Our subject demands that we should notice briefly one part of the later Vedic literature, namely, the Upanishads. These are divisions or tractates embodying the *divinity*, if we may use the term, as distinguished from the ritual of Hinduism. Fifty-two of these belong to the Brâhmana, or second part of the A'tharva-Veda, which stands fourth in the series. Some of these, however, are also reckoned as belonging to other Vedas, and a number of Upanishads exist only in detached form. Max Müller reckons them to amount in all to no fewer than a hundred and forty-nine, many of which, however, are of late date and small importance. In the earlier Upanishads, the first speculative attempts are made to solve the problems of the nature of the Supreme Being, and of the human soul. Though not themselves philosophical treatises, they contain the seeds of subsequent speculations. In them the outlines appear, afterwards developed into diverging systems.

In the second period of its history, Hinduism reached its acme in outward splendour and literary genius. A great

intellectual ferment appears to have taken place, giving origin to diverse schools of thought, some of which openly disowned the authority of the Vedas. The chief of these heresies was that of the Bauddhas, or Buddhists. So powerful did it become as to imperil the ascendancy of Brâhmanism proper; and, although finally exterminated in India by its exasperated foes, it yet spread far and wide beyond its original seat, and still numbers many millions of votaries. The kindred sect of the Jainas seems to have appeared later on the field, and to have fared better, having survived the storm, and constituting at this day an important section of the Hindu community. Other heresies were less conspicuous and aggressive, and made little stir by their rise or disappearance. The same speculative spirit that produced these schisms gave birth in addition to various philosophies which professed to be orthodox, and to expound their tenets in consistence with the import of Vedic texts. Another feature of the time was the division of the community into a number of sects, each attaching itself to the worship of some one special deity. In primitive Hinduism there was no such rivalry of gods, but the worshipper sought by suitable offerings to propitiate the goodwill of all. In course of time, however, titular deities were adopted, and then a contest for pre-eminence arose, each god being magnified as the Supreme by his own immediate votaries. The battle turned more especially on the respective claims of the three deities composing the Trimurti, or Hindu triad, namely, Brahmâ, Vishnu, and 'Siva, the personifications of creation, preservation, and destruction. Brahmâ, the creator, fared but ill in the strife, and his worship almost entirely disappeared. With Siva, it went better, and he was extensively worshipped under various forms, but chiefly under that of the Linga, or Phallic emblem, the idea of reproduction having become associated with that of destruc-

tion. The most popular member of the Trimurti, however, was Vishnu, not so much in his original form as in some of his numerous âvatârs or incarnations. Of these, the favourite ones were Râma and Krishna, whose heroic adventures and marvellous exploits are respectively recorded in the splendid epic, entitled the Râmâyana, and in that colossal poem, the Mahâbhârat. One form of Krishna, named Jaggannâth (commonly written Juggernaut), attained a special local celebrity in Orissa, as is well known, through the frequently reprinted passage in Claudius Buchanan's *Christian Researches in the East.* Besides the great epic poems we have mentioned, the period we are considering also witnessed the appearance of the Purânas. They are eighteen in number, each containing a cosmogony and a huge mass of mythological tales. Some take the side of Vishnu, and others of S'iva, and of course each tells its story so as to suit its own end. The speculations of the Philosophical schools are also introduced, variously modified and commingled, so that some acquaintance with them has become diffused throughout the entire mass of the common people. These later works are written in a highly polished and elaborated style of language; very different from the obscure archaic Sanscrit of the Vedas. Although, therefore, the paramount authority of the more ancient books was still formally acknowledged, they were as completely displaced in popular use, as the Scriptures were in the Middle Ages by the Legends of the Saints.

The third phase of Hinduism is that which has existed for the last few centuries. One marked peculiarity in it is the prominence given to the worship of S'akti, or the female principle. The word S'akti was originally used to designate the *volition* or *energy* of the deity, by means of which he acted. In course of time it came to be personified as a female, and was identified with the spouse of each several

god. The professed worshippers of this school are, however, with small exception, the followers of the wife of S'iva, in one or other of her many forms. As Durgâ, she has annual celebrations in her honour, which have come conspicuously under the notice of Europeans, from the vast and lavish scale in which they are carried on in Bengal. Under the hideous form of Kâli, "whom the blood of man delights for a thousand years," she is propitiated with cruel and revolting rites. Obscenity could not fail to mingle in such service. There are *left-hand* sects, as they are called, whose religious rites are still baser than the hateful worship offered openly to those demon goddesses. The Vâmâchâris, and their kindred societies, choose the darkness for the celebration of their services. These are held in private houses, and both men and women must be present. The offerings are presented to a naked female who personates the goddess, and the rites close with the foulest orgies. To show that this is no mere fable, Professor H. H. Wilson has quoted the original texts by which all these abominations are enjoined. The worship of S'akti has been especially fostered by a class of works entitled *Tantras*, in which great stress is also laid on the use of mystic gesticulations and formulas of incantation. Another feature of later Hinduism has been the vast multiplication of mendicant religious orders, the members of which, though originally of the lowest castes, or none at all, yet claim the highest spiritual powers, and demand the greatest reverence and most unquestioning obedience from their supporters. Along with this has grown up the inculcation of a wild and passionate fanaticism, in which the devotee aims to be one with his deity, and conceives that his frensied fervours raise him immeasurably above all need either of other services or of the ordinary restraints of civil and social life.' It is easy to judge how demoralising must be the effects of such a faith.

Having brought our historic sketch of Hinduism down to the present day, let us revert to the more special topic of its philosophic schools. Besides such as are deemed heretical, there are six which are reckoned orthodox. These, however, are associated in pairs, thus making a great threefold division. The first pair, included under the name *Mimânsâ*, deal professedly with the Vedas—the former branch concerning itself with ritual and rules of interpretation, and the latter branch, which takes the special designation of the *Vedânta*, laying down a system of Pantheistic Theosophy. The second pair consists of the Sânkhya and the Yoga schools, the first of which teaches a Dualism in Nature, and lays the foundation on which the second rears a system of ascetic observances. The remaining two are the Nyâya and the Vais'éshika; the one a dialectic system, and the other an atomic theory. It may conduce both to brevity and clearness if we confine our attention to two only of the orthodox schools, namely, the Vedânta and the Sânkhya, and then touch lightly on the Bauddha and the Chârvâka, among those counted heretical. A good many things are introduced into their writings, on which we need not linger; such as discussions on the sources and objects of knowledge; geographical and astronomical notions; precepts for the regulation of life; rules for religious observances; and extravagant tales concerning their founders. We may safely omit all the legends, as well as all that pertains to logic and to physics, to morals and to ritual, and confine ourselves to the region where philosophy meets religion. The great topics that concern us here are God, the Universe, and the Soul, the relations of which give rise to two profound problems, the cosmical and the psychical.

There are two points, in regard to which there is considerable unanimity of view among all the various schools of

Hindu thought. One is, the object to be attained by the study of Philosophy, which is no other than final liberation (moksha), or emancipation of the soul from material trammels. Philosophy with them does not aim simply at the mastery of truth. It is represented as the only means for attaining the most desirable consummation of being. To the vast multitude of the uninstructed, there is no other way of self-elevation but by *works*, in fulfilling the duties of life and offering the appointed oblations. Thus may they attain to participation in the power and felicity of the gods. Such happiness, however, is essentially transitory; and it were better to win a condition that could never more be affected by the evil influence of change. That beatitude belongs to the spirit set free from its material environments, and reabsorbed into the Infinite. How can this be won? Not by works, but by *knowledge*. A true discrimination of principles is the effective instrument of the soul's emancipation. The orthodox philosophies constitute, in short, an esoteric religion, professing to be supplementary to the Vedic ritual, but really claiming a superior position to it, while the bolder heretical schools openly disavow the Vedas, and claim to be the true religion themselves.

The other point, in which the various schools mainly agree, is in holding the theory of recurrent cycles of world-formation and destruction. Each of the Purânas, as we have noticed, opens with a cosmogony, of which we may sketch a typical outline. There was a time when nothing existed but Brahma. This word is in the neuter form, and is not to be confounded with Brahmâ, the first person in the Hindu triad. It is employed to denote the primal being, who, or which, is usually represented as devoid of all qualities. This original substance remains in unconscious quiescence for a vast period. At last it wakes to self-consciousness, expands and develops itself into the five ele-

ments of ether, air, fire, water, and earth, which become variously commingled and moulded into gods, men, and the whole universe of things. These run their appointed course through successive ages, till at last they all resolve themselves again into the elements, which coalesce and return to the same condition whence they issued. All again is void and darkness, absence of thought, sensation, form or quality, till the next re-awakening, when the same course of events is again run through, to be followed by the same virtual annihilation. Thus the history of the universe repeats itself continually, and things go round and round in a perpetually recurring cycle. This simple scheme is variously modified and overloaded in the different Purânas. A cosmic egg, for instance, is introduced as the first step in creation. Again the female idea is brought forward, and we are told that the deity divided himself into two, one side becoming woman, the other remaining man, from the intercourse between whom sprang the gods and other orders of beings. The process becomes, in some of the Purânas, a most tedious and cumbersome affair, in which all sense of sublimity is lost amid the puerilities and extravagances of the fable. We need not attempt these mythological mazes, as our interest centres only in the subtler underlying ideas.

To take the systems we have named a little more in detail, let us begin with the Vedânta. The word signifies the "end of the Veda," and the professors of the system maintain that it is the one most thoroughly in accord with their ancient Scriptures. It was probably not fully developed till after the rise of some of the other systems. The oldest text-book of its principles is the Brahma-sutra. This work, according to the fashion of the period, consists of aphorisms (sutras), which have been laboriously made as concise as possible. A number of commentaries have been written to elucidate so brief and obscure a text; the best of

which is by the famous controversialist, S'ankarâchârya. The ground principle of the Vedantists is the Unity of God and the world. All things that exist are parts of the Infinite Being, who was the original substance, and still continues the real basis of everything. Matter and mind, in short, are only modifications of a single entity. This Pantheistic dogma, however, is modified in application, and is made to include these two positions: First, All individual souls are a part of the Infinite soul; and, Second, The whole material universe is a development or emanation out of soul. It is evident that a kind of dualism is thus introduced into the theory. The souls of men, according to this view, are never born and never die. They are divided off for a season from the Infinite soul, and are finally merged into it again. Other things are an efflux, but of different sort and quality from the originating source. The separation of individual souls from the Supreme one is effected by *ignorance*. This has both an *enveloping* and a *projecting* power. Through the first, the soul becomes enclosed in a subtle body, which is made up itself of three sheaths, one within the other. The innermost sheath consists of intellect or judgment (buddhi), and the five perceptive powers, by which are meant the mental faculties corresponding to the five bodily senses. The second sheath is composed of the faculty of imagination and volition (manas), together with the five active powers; and the third, of the five vital airs, as they are termed, combined also with the five active powers. The subtle body thus constituted continues to envelop the soul, even after death has destroyed the gross outer frame. Should great merit have been acquired during life, by sacrifice or other means, the soul, enclosed in its etherial vehicle, ascends to the paradise of the deity whose favour has been won. After enjoying the pleasures of the place for a period proportioned to the amount of merit, it must descend to earth again, and

be born in some new body. In like manner the outrageously wicked are punished in some infernal region for a sufficient season, and then attain to another birth. Those who are neither righteous nor wicked overmuch, escape both the paradise and the purgatory, and pass at once into some new form, exalted or ignoble in proportion to their worth. Such, for instance, as have been guilty of cruelty towards the lower animals are compelled to become the very creature they have ill-used, and endure the same inflictions from their former victims, re-born in human shape, to become their tyrants. This process goes on through thousands of births, till the end of the great cycle comes, when the whole universe is dissolved and absorbed into its original essence. Absorption into the supreme soul, however, may be gained at any time by the use of the proper means, which is *knowledge*. Works, indeed, may be of service, but only by way of preparing the mind, "as a steed carries a rider to his home." Even this partial recommendation of works appears to be a compromise with the Vedic institutes, and is coupled with strong dissuasives from the notion that works have any effect in themselves for procuring liberation. The essence of the Vedantist view is, that by true knowledge only,—that is, the knowledge that the soul itself is Brahma,—the enveloping vehicle is destroyed, and, as the spark falls back into the fire, or the liberated drop mingles again with the ocean, so also the soul becomes lost in God. The whole creation thus has its seat in ignorance, that is, in the belief that we individually exist. From that self-assertion flows belief in the material world. This is to be conquered by reversing the process. We must begin by withdrawing the mind from outward phenomena, and rise at last to the cessation of self-conscious thought. When we no longer feel "I am," we reach perfection.

We have thus traced the Vedantist history of a soul, and must return for a moment to the material world. We saw that ignorance had two effects; on the first of which, in *envelopment*, we have dwelt sufficiently. But it has also a *projective* power, in consequence of which an emanation takes place of the subtle and the gross elements which thereafter constitute the outward universe. Soul or spirit, therefore, is the root of being, from which matter is an effluence, both, however, remaining one in substance. This view appears to be founded on the assumed axiom that the effect must partake of the nature of the cause, or, in other words, whatever is brought into being must be identical in essence with that whence it flows. There was perceived to be a stumbling-block in the application of this principle, arising from the incompatibility between the properties of matter and those of spirit. How could these two be the same substance when their qualities were so contradictory? It was apparently to escape from this difficulty that the idea of Mâya, or *illusion*, was propounded. Colebrooke is of opinion that this formed no part originally of the Vedânta philosophy, but was afterwards introduced into it. According to this theory, there is no such thing as matter at all; nor do those things actually exist which we seem to perceive. They are like the personages and adventures of a dream, which appear indeed real at the time, yet have no being but in fancy. Thus the whole so-called creation has only an ideal existence. It is shadow, not substance—thought, not reality—not a creation at all, but a mere phantasmagoric semblance. This sort of Idealism has shown itself elsewhere, but only in India has the common mind become saturated with it, and the word Mâya, is as familiar to the lips of the poor labourer as of the learned Pandit. The Pantheism of the speculative schools has been popularised by

its introduction into the cosmogonies contained in the Purânas. The name Mâya, as well as S'akti, is there bestowed on the female power, who takes part with the deity in creation, whence it follows that the whole of their joint handiwork is illusive.

We may illustrate one or two of these points by brief extracts from that celebrated section of the Mahâbhârat, entitled the Bhâgavat-Gitâ. This is composed in the form of a dialogue, supposed to take place during an interval in a battle, and the speakers are Arjuna, a Pandu prince, and Krishna, who acts as his charioteer and friend, but who is in reality an incarnation of Vishnu. He is the speaker in the words we shall quote, which are taken from the old translation by Wilkins:

"I myself never was not, neither thou, nor all the princes of the earth; nor shall we ever hereafter cease to be. The soul is not a thing of which a man may say, It hath been, it is about to be, or will be hereafter; for it is a thing without birth; it is ancient, constant, and eternal, and is not to be destroyed in this its mortal frame. As a man throweth away old garments and putteth on new, even so the soul, having quitted its mortal frames, entereth into those which are new. The weapon divideth it not, the fire burneth it not, the water corrupteth it not, the wind drieth it not; for it is indivisible, inconsumable, incorruptible, and is not to be dried away. It is eternal, universal, permanent, immovable. It is invisible, incorruptible, and unalterable; therefore, believing it to be thus, thou shouldst not grieve."

"I am the creation and the dissolution of the whole universe. There is not anything greater than I, and all things hang on me, even as precious gems on a string. I am moisture in the water, light in the sun and moon, invocation in the Vedas, sound in the firmament, human nature in mankind, sweet-smelling savour in the earth, glory in the

source of light, in all things I am life. . . . I am the eternal seed of all nature. I am the understanding of the wise, the glory of the proud, the strength of the strong."

"Those who are acquainted with day and night, know that the day of Brahma is as a thousand revolutions of the yoogs (ages), and his night extendeth for a thousand more. On the coming of that day, all things proceed from invisibility to visibility; so, on the approach of night, they are all dissolved away into that which is called invisible. The universe even, having existed, is again dissolved, and now again, on the approach of day, by divine necessity, it is reproduced. But what, upon the dissolution of all things else, is not destroyed is superior and of another nature from that visibility. It is invisible and eternal. He who is thus called invisible and incorruptible is even He who is called the supreme abode, which men having once obtained they never more return to earth."

Schlegel's Latin rendering of the first passage is so fine that it may excuse insertion of the greater part of it:

"Non nascitur moriturve unquam; non ille exstitit, exsistitve, non exstiturus: innatus, immutabilis, æternus ille, priscus, non occiditur occiso corpore. . . . Perinde ac obsoletis vestibus abjectis, novas sumit homo alias, sic abjectis corporibus obsoletis, alia ingreditur nova spiritus. Non illum penetrant tela, non illum comburit flamma, neque illum perfundunt aquæ, nec ventus exsiccat. Impenetrabilis ille, incombustibilis ille, imperfusibilis ille, nec non inexsiccabilis, perpetuus, omnivagus, stabilis, inconcussus ille atque æternus, invisibilis ille, inerrabilis ille, immutabilis ille declaratur. Quare, quum talem cognoveris, non luctu eum prosequi te oportet."

The Sânkhya system, to which we shall next proceed, has been developed with great elaborative skill, somewhat after the fashion of the mediæval schoolmen; and the other

philosophies of India were probably much beholden to it for their subtle distinctions and definitions. It appears to have been the most ancient in its rise, and has exerted a most powerful influence, as having furnished the starting point for Buddhism, while retaining its own place among Brahminical speculatists. The reputed founder was Kapila, of whom, according to the Hindoo manner, various marvels are narrated, and to whom the authorship is ascribed of the ancient aphorisms, embodying the principles of the system. The radical difference between the Sânkhya and the Vedânta is that the former is a dualistic theory, and not monistic, like the latter. Two original and eternal principles of being are recognised. Nature (Prakriti), and Soul (Purusha). From the union of these two, twenty-three other principles are produced, and the whole twenty-five, taken together, form the constituents of the entire material and intellectual creation. The first product which flows from the alliance of spirit and matter is Intellect (Buddhi, called also Mahat, the great one); then follows self-consciousness; and then the perceptive and active faculties; and the subtle and gross elements appear in due order. The whole universe thus originated is affected by three cosmic qualities, the names of which it is impossible to render adequately by any single word in another language, on account of the generality of the conception. The first quality (sutwa) includes every thing in the physical and mental world that partakes of light, virtue, and happiness. The third quality (tamas) denotes all that is of an opposite character, namely, darkness, vice, and misery. The intermediate one (rajas) expresses whatever is *coloured,* or possessed by tumult or passion. A very noticeable feature in the Sânkhya philosophy, is the view that the union of Spirit and Nature is indispensable for the manifestation of active qualities. In their isolated state, matter remains absolutely inert, and

spirit as utterly torpid. Nothing can be predicated of either of them but mere existence. This view differs considerably from our notions, both of chaos and of disembodied spirit. By chaos, we mean matter without arrangement of parts, but still endued with every elemental quality; and pure spirit, on the other hand, is familiarly regarded as quite capable of every mental process, with the exception of physical sensation. According to the Sânkhya theory, both remain, as it were, dead, till the access of spirit vitalises nature, which then becomes the prolific all-productive power. Soul produces nothing itself, but becomes the enjoyer of Nature's products. Their alliance is compared to that of a blind man with a lame, one borne and directing, the other bearing and directed, thus accomplishing an object in concert of which neither singly was capable. The soul is compelled by necessity to seek fruition through such union with nature, after enjoying which it seeks again for liberation. The whole course of things depends on this alternation of conditions; creation flowing from the incarnation of spirit, and dissolution from its disembodiment.

The Sânkhya, like the Vedânta, assumes the axiom that all products must be of the same substance as that from which they derive their being. From this principle, the Vedânta infers the identity of Nature and God. The Sânkhya, holding the essential antithesis between matter and spirit, draws the alternative conclusion that both must be original and eternal. Another great point of difference is that the Vedânta holds all individual souls to be parts of the one infinite soul, whereas the Sânkhya regards them as radically separate and multitudinous. It argues this from the facts of self-consciousness. If there were only one soul, it would, at the same instant, be conscious of everything in the universe, whereas every individual soul has its own distinct experience. The Sânkhya system is charged with

being atheistic, in not acknowledging any Supreme spirit. One branch of it, however, recognises such a belief, and seems to hold the Supreme soul to be the sum of all individual souls. This theory approaches near to the *Illusion* school of Vedantists, the difference being that one asserts and the other denies the actual existence of matter. The term Psychitheism may be applied to this view, which makes all *souls* a part of God. The Yoga system professes to be supplementary to the Sânkhya, but occupies itself mainly with directions for attaining to liberation by such means as repeating ओं, *om*, the mystical name of God, thousands and thousands of times, holding in one's breath, sitting in divers constrained attitudes, withstanding the calls of nature, and other such sage devices for ridding one's self of the uneasy dower of his humanity. In the Matsya Purâna, there is a remarkable passage which identifies Mahat (the first product from the alliance of Nature and Soul) under the influence of the three qualities of goodness, passion, and sin, with the Trimurti, or divine Triad. "In the aggregate, it is the deity; but distributive, it appertains to individual beings"—"being one person and three gods." The usual Purânik rendering, however, of the Sânkhya consists in identifying Prakriti, or Nature, with the female principle in creation, with which we have already become familiar under the names of S'akti and Mâya.

It is evident that Dualism can be reconciled with Pantheism, by recognising a duality in the nature of the deity. As man is one, but is made up of body and soul, so may God be one, but include in his essence both matter and spirit. This view was actually developed at a later stage among some of the Vaishnavas, or worshippers of Vishnu, and became very popular, being disseminated in books written in the current dialects. The best compend of the ancient doctrine is a short series of seventy-two verses

(Kârikâ), written by Iswara-Krishna, and characterised by extraordinary comprehensiveness and terseness. One or two of these may be quoted from Professor Cowell's translation.

"9. Effect subsists (antecedently to the operation of cause); for what exists not, can by no operation of cause be brought into existence. Materials, too, are selected which are fit for the purpose: everything is not by every means possible: what is capable does that to which it is competent; and like is produced by like."

"59. As a dancer, having exhibited herself to the spectator, desists from the dance, so does Nature desist, having manifested herself to the soul."

"66. He desists because he has seen her; she does so, because she has been seen."

The Buddhist system, which we have next to take up, has risen from the rank of a mere school of philosophy, and become one of the great religions of the world. It is calculated that no fewer than four hundred millions, about a third of the entire population of the globe, profess this form of belief. The name is derived from the word Buddha, which is a designation of the founder, and signifies "one who knows the truth." The names are given of twenty-four Buddhas, who appeared in previous great periods of cosmic development; and each future cycle will have one of its own, who will instruct the new race in the same sublime verities. The Buddha of the present cycle appeared and taught mankind in the person of a Hindu prince, who was born about B.C. 600. His proper name was Siddartha, but he is more usually called Gautama, from the name of the "solar" race of princes to which he belonged, and S'âkya, which was his family designation. This is commonly given as S'âkya-Muni, the latter word signifying "ascetic," or "holy sage." The king, his father, as goes the tale, warned that his son

would become a recluse, sought to avoid the disgrace by uniting him, at the age of sixteen, to a most beautiful and fascinating spouse, and surrounding him with all the choicest pleasures of a court. Chancing, however, one day to meet an old man, wrinkled, shrunk, and bowed down with very age, he was smitten to the heart at the sad spectacle. Shortly afterwards, the impression was deepened by the sight of a leper, covered over with loathsome and revolting sores. A corpse, in all the ghastly horrors of decomposition, completed the effect; he broke away from his voluptuous bonds, and gave himself up to the lonely hardships of an ascetic life. Having withstood the most fearful temptations from wicked demons, and wandered about for many years teaching the truth he had discovered, he attained at length to the exalted condition of a Buddha. The dark veil of oblivion was rent which had shrouded from his view the long tract of his pre-existent years, and he could recal in sharpest distinctness every incident in the millions on millions of ages during which he had been born in every variety of human condition and animal form down to the lifeless clod, and had passed in turn through every one of the numerous seats of bliss and regions of torment above and below the world. The religion he taught obtained wide acceptance, and for some centuries covered a large part of India proper, leaving memorials of its greatness in marvellous temples hewn out of the solid rock. Though it has disappeared on its native soil, except on its northern outskirts, yet in Ceylon, and Burmah, China, Thibet, and Tartary, it has its countless votaries. It is a humane and charitable system, which may account in part for its power. Unlike Brahminism, it offered its blessings freely to every class. Hinduism excluded all not born within its pale, and even to these proved itself an ironbound system of social and religious distinctions. Buddhism opened the door as wide to outcast

as to noble, and to down-trodden, degraded woman as well as man. Inspiring a zealous missionary spirit, it sent forth devoted teachers ready to hazard their lives for the cause. In other respects its regard for sentient life condemned the sacrifices enjoined by the Vedas, and its ascetic spirit, combined with a special organisation, showed itself in the erection of countless *vihâras* or monasteries, as they may be termed, of those monks of the East. The sacred literature of Buddhism is overwhelmingly voluminous, but the most of it consists only of absurd speculations and monstrous legends. The essence of the system can be very briefly given. The cause of all misery is birth; for had we not been born we should never have suffered. Death brings no release, for the soul is compelled by inherent necessity to take some form correspondent to its condition. Could every desire to seek or to avoid be destroyed, the soul would escape from that necessity. But desires, through some intermediate links, are derived from ideas, and such ideas are the offspring of ignorance. There, then, is the final source of all our misery. Let ignorance be overcome by the knowledge that all these ideas are illusory, so shall the soul be released from desire, and all that flows from desire; it will pass at death into no new form, but attain to passionless, changeless, eternal calm (nirvâna). This system strongly inculcates an ethic rule, yet absolutely excludes the conception of a God. The recompense of virtue and retribution for crime come, as it were, by fixed physical laws which work by a fatal necessity. That such a belief should rear temples and offer worship seems an inconsistence. These things were probably an aftergrowth; but if not, the worship is to be viewed as a mere contemplation of ideal excellence, or as effective, not by propitiation of a deity, but through some inherent magical power. The term employed by the Buddhists for the perfect condition, seems to convey the idea of

annihilation more strongly than the word used by the Hindus. Benfey gives the primary meaning of मोक्ष, *moksha*, as "liberation," and of निर्वाण, *nirvâna*, as "extinction." In their religious use, Burnouf says the first signifies "l'exemption des liens du corps et des misères de la vie;" and the second, "anéantissement des conditions de l'existence individuelle." Spence Hardy deems that the distinctions drawn by Buddhist writers between the latter state and absolute annihilation are very shadowy. It is believed that even on earth this condition can be partially attained by the mind passing into a kind of trance or ecstasy, "where there are no ideas, nor the idea of the absence of ideas."

The fourth and last of the systems we proposed to notice is that of the Chârvâkas, said to be founded by Vrihaspati.

We need not linger on it, as it is simply Materialism; that grossest form of faith, if faith it can be called, which scouts all belief in the spiritual and unseen, and looks to this poor fleshly life as the be-all and the end-all that remains for man. This Sadducean spirit shows itself under every creed, proving how deep it lurks in the human heart. There is nothing in it, therefore, specially oriental, but it completes the cycle of beliefs along which we have been travelling. The Vedânta, we saw, is a monistic system, asserting in all its forms the existence of God, and in some of them denying the existence of matter. The Sânkhya is dualistic, recognising both spirit and matter as eternal, and tending on the whole to Theism. The Buddhist religion is an atheistic dualism; and in the Chârvâka we come round to Monism again, but one which, in opposition to the Vedânta, asserts the existence of matter, and denies that of God and soul. There are multitudes, no doubt, in all countries who take this view, but make no profession of it. If religion be mere delusion, they may serve their own

interests by conforming to it, or repudiating it, as may suit best. The professed views of the Chârvâkas may be sufficiently indicated by quoting two or three of their verses, from the translation of a passage in Mâdhavâchârya's Collection of Philosophic Systems:

"There is no heaven, no final liberation, nor any soul in another world.

"While life remains, let a man live happily: let him feed on ghee (clarified butter), even though he runs into debt.

"Hence it is only as a means of livelihood that the Brâhmans have established here,

"All these ceremonies for the dead; there is no other fruit anywhere.

"The three authors of the Vedas were buffoons, knaves, and demons."

Although India was very much an unknown land in ancient times, yet for centuries before Christ its speculations had begun to tell on the classic world. Even in those days of fettered commerce and tardy travel, thought had a diffusive power. It is indeed impossible to say how far the same ideas, springing up on distant soils, were original or imported. As viewless seeds are borne by the wind to far-off spots, where they root and rise in sudden and surprising growth, so thoughts are often conveyed, without the process being distinctly recognised, to receptive intellects, which they stimulate to the origination of congenial theories. In such cases, priority may be allowed to weigh in the claim to parentage. Judged by this canon, it cannot be doubted that Greece drew part of her philosophic inspiration from India, as well as from the kindred system in Egypt. Not to mention other names, Plato himself taught the transmigration of the soul with marvellous felicity of

diction and elevation of feeling. When such ideas filled the air, we need not wonder if even Fathers of the Church caught a little of the infection. Origen especially was accused of imbibing the subtle venom. Jerome charges that daring and erratic genius with holding that, *in some manner*, human spirits are identical with the Divine. The passage occurs in his Epistle to Avitus, and runs thus: "In ejusdem voluminis fine conjungit omnes rationabiles naturas, id est, Patrem et Filium et Spiritum Sanctum, Angelos, potestates, dominationes, cætereasque virtutes, ipsum quoque hominem, secundum animæ dignitatem unius esse substantiæ. *Intellectualem*, inquit, *rationabilemque naturam sentit Deus et Unigenitus Filius ejus et Spiritus Sanctus:. sentiunt Angeli et potestates cæteræque virtutes: sentit interior homo qui ad imaginem et similitudinem Dei conditus est. Ex quo concluditur, Deum et hæc quodammodo unius esse substantiæ.* Unum addit verbum *quodammodo*, ut tanti sacrilegii crimen effugeret."

Origen's work, περὶ ἀρχῶν, here alluded to, only survives in a few fragments, and in the Latin version of Rufinus, in which no such doctrine is laid down. The passage, therefore, must have been omitted by the friendly translator, or the vehemence of Jerome must have outrun his accuracy in his attack on his former friend.

Among the schoolmen, a touch of Pantheism occasionally shows itself. The stream of Neo-Platonism was carried down through the Middle Ages as an esoteric school within the synagogue, the doctrines of which are known as the Kabbala. There we meet again with the Original Being (אין סוף, En Soph); with Emanations (סְפִירוֹת, Sephiroth); with Metempsychosis (Gilgul Neshamoth); and with the final union of all separate spirits with Infinite Spirit, Samael himself, the prince of evil, not being excluded. Kabbalistic views have exercised no general influence, although a few

men of note have been captivated by them, as, for instance, Reuchlin, the great Hebraist, and the Platonic Henry More. Modern Pantheism may be said to have begun in the seventeenth century, with Benedict Spinoza, who ascribed to God a duality of original attributes, namely, *thought* and *extension*. It is in the present century, however, that Pantheism has received, philosophically, a portentous development, the leading spirits in the movement being Schelling and Hegel, whose views grew out of those of Fichte, and remotely from those of Kant. Schelling, in his earlier teaching, held that Thought and Nature are opposite poles of the same thing. Nature is the development of God, and God, the life of Nature, or soul of the world. When he spoke again, after long silence, it was with altered voice, proclaiming an inherent dualism both in God and the human soul.

Hegel's philosophy viewed the Divinity as passing from unconscious existence to self-consciousness in the history and development of humanity. His views were pushed by a large section of his followers to the most unblushing deification of the human spirit. Schelling's view was a Cosmotheism, and Hegel's an Anthropotheism. Schelling's splendid genius breathed a new inspiration into all the sciences, but Hegel's influence was more powerfully felt in theology. Not to mention others, Strauss adopted his principles as the foundation of his method in dealing with the records of the Life of Christ. The special importance of the Hegelian idea may excuse us for quoting a statement of it by the historian of the school, Dr. Michelet, of Berlin, with the Latin rendering given by Professor Mill:

"Gott ist nach Hegel nicht eine Person, sondern die Persönlichkeit selbst, das einzige wahrhaft Persönliche, wogegen das subjecte, welches noch im Gegensatz gegen die göttliche Substanz eine besondere Person sein will, eben das Böse ist. Weil Gott die ewige Persönlichkeit ist, so hat er

ewig das andere seinere, die Natur, aus sich hervorgehen lassen, um ewig als Geist der Gemeinde zum Selbstbewusstsein zu gelangen. Ist dieser Geist im Menschen, so ist es der Mensch nicht mehr, der in diesem Einzelnen lebt, sondern Gott selbst, der in ihm personlich geworden."

"Deus, ex Hegelii sententia, non est Persona sed personalitas ipsa, unicum scilicet verum personale: quocirca omne subjectum, quod nihilominus divinæ substantiæ oppositum diversa quædam persona haberi velit, malum est, immo τὸ κακόν. Cæterum dum Deus æterna personalitas est, alteram illam sui (effigiem) Naturam ex se æternum prodire sivit, quo tanquam Spiritus seu Anima Universi in sui ipsius conscientiam perveniret. Sit modo hic Spiritus in homine, profecto non est amplius homo, qui in hoc individuo vivit, verum Deus ipse in eo personalis factus."

The same radical idea, as taken up and applied in Theology by Strauss, may be best stated in that writer's own words:

"Though I can conceive that the divine Spirit in its exterior and condescending manifestation is the Human, and the human spirit in its reflection into itself, and its elevation above itself, is the Divine; yet can I not on that account represent to myself how divine and human nature can have made up the distinct yet connected ingredients of an historical person?" "Taken as residing in an *individual* God-man, the properties and functions which the Church doctrine ascribes to the Christ are inconsistent and self-contradictory; but in the idea of the *genus* (or race of men), they harmonise together. Humanity is the union of both natures: it is the *God made man*, the infinite manifesting itself in the finite, the finite spirit reminding itself of its infinity; it is the child of the visible Mother, Nature, and the invisible Father, Spirit." The closing part of this passage might have been quoted, word for word, from an exposition of the Sânkhya philosophy.

The leading principles of other Indian schools have not failed to show themselves on the modern stage. The undiluted Atheism of the Chârvâka sect obtained vast ascendency towards the end of last century, especially in France. In our own day, a strange rehabilitation has been given to the atomic theory, taught by the Vais'eshika school in India, and afterwards by Democritus in Greece. Molecular force accounts for everything. The universe began in dust, and even all developments of life have arisen but from the clashing of atoms.

SPONGES,

Their Anatomy, Physiology, and Classification.

By THOS. HIGGIN, of Huyton.

Professor Haeckel, in the introduction to his recent work on Calcareous-Spiculed Sponges, remarks of sponges in general, that no other Class, in proportion to its importance, has found so few students, shows such a scanty literature, has been left by naturalists so much in doubt as to its proper nature, and has caused such a multitude of contradictory opinions. *

It is true that sponges have engaged the special and particular attention of few of the many eminent men who, from time to time, have found it necessary to bestow upon them some consideration, but the reason for this lies chiefly in the fact that the study could only really commence when a microscope of sufficient power could be brought in to aid the observer; and if we add to this the necessity for residence at the seaside, in order to observe the marine species in a living state, we cannot feel surprise that few persons competent to undertake the work have been so circumstanced as to be able to prosecute the study successfully.

Moreover, fifty years have not yet elapsed since the first compound achromatic microscope was made in this country, and it has only been during the latter half of the period that this instrument has come into general use, so that it is only within the last twenty-five years that any exact knowledge of the anatomy and physiology of these organisms has been obtained. There has not, therefore, been time for

* *Biologie der Kalkschwœmme*, p. 8.

the accumulation of much literature on the subject; and, as might be expected, much of what has been written, and much of the most important matter recorded, is in a scattered state in the form of papers communicated to various scientific periodicals, published in other countries as well as in our own, and not very accessible to would-be students. A short statement, therefore, of some of the most important contributions to our knowledge of the nature of sponges, which have been made since the introduction of the compound microscope, may perhaps be found interesting and useful.

Dr. Johnston, in his able work on *British Sponges and Lithophytes*, published in Edinburgh, in 1842, gives an excellent account of the "contradictory opinions" held by eminent naturalists of the last and the present century, as evidence was adduced from to time, showing the affinity of sponges with either well-known animal or well-known vegetable organisms. Thus he tells us that, in 1760, Linnæus arranged *Spongia* amongst the Cryptogamic Algæ; but seven years afterwards, in the 12th edition of the *Systema Naturæ*, he placed Sponges with the Zoophytes. Ellis noticed the contraction and dilation of the pores, and was satisfied of the animal nature of sponges. Pallas adopted his views, and considered sponges as "the last link in the chain of animals from which nature stept without effort or leap to the vegetable kingdom." Dr. J. E. Gray, in 1824, argued earnestly against the animality of sponges; but in 1825 became a convert, and considered them to be true corals, allied to *Antipathes* and *Gorgonia;* afterwards he seems to have wavered a little, but was satisfied eventually to place them in the animal kingdom.

About this time (1824), Dr. R. E. Grant, afterwards Professor of Zoology and of Comparative Anatomy at the University College, London, met with the sponge *Halichondria panicea* in an oviparous state, and developed the

embryos in watch-glasses. He also showed the existence of the waterstream from the vents, by placing the living sponge in a shallow vessel of water, and sprinkling the surface with fine dust. But Dr. Link, Professor of Botany at Berlin, did not consider the current as conclusive of animality, and viewed the capsules of *Spongilla* as distinct sporangia, and therefore placed sponges amongst the Algæ.

A review, however, of all the facts known when Dr. Johnston wrote his work satisfied him of the animal nature of sponges; and it has since become almost universally admitted that the sponge is an animal organism.

It has been stated, however, that it is only an indefinite general impression, and it cannot be denied that this is in a great measure true; but the latest observations on the lower plants and lower animals have not made it more easy to state fundamental differences, or to draw a distinct line of separation between the animal and vegetable kingdoms.*

The reasons, however, which are now given for placing sponges on the animal side of this rather undefinable line, are well expressed by Professor Rolleston, in his *Forms of Animal Life*, p. 164, where he says—"The motile phenomena noticeable in these creatures, and their great need for and rapid consumption of oxygen, without which, as supplied by constant additions of fresh water, the *Spongillæ* may be observed to die and putrefy with great rapidity, are from the physiological point of view very strong evidence of their animal character. The histological evidence, however, drawn from the detection in them of ciliated as well as non-ciliated epithelium, of cells for the formation of spicula, and above all of contractile fibre-cells which, though not detected in

* At the meeting of the British Association at Belfast, in 1874, attention was called by Mr. W. Archer, of Dublin, to an organism which, in the early stages of its development, would be called a vegetable, whilst in the later ones it is as distinctly animal.

Spongillæ, do exist in more highly organised sponges, (*Ceratospongiæ* and *Corticatæ*,) is, as Kölliker has remarked, quite conclusive upon the question."

Outward Form.

Sponges present themselves to our notice under a variety of forms, the most common of which, in positions much exposed to the violent action of the waves, are the massive and flatspreading, and under conditions favourable for an erect growth, palmate, digitate, fanshaped, cupshaped, and shrublike. The same species, however, frequently appears under different forms, and locality only will not account for the variations noticeable in outward form and appearance. *Halichondria panicea* is found in the same bay on our own coast in four distinct forms—cockscomb-like, flatspreading, fistulous, and massive—all undistinguishable from each other as regards detail when brought under the microscope; and Professor Haeckel, speaking of the instability of outward form, remarks that the systematist who would take external form alone for a specific character might at his pleasure distinguish ten, twenty, or even one hundred species from the individuals of the extremely variable sponge, *Ascandra variabilis** (H.), found in one locality. Some of the more highly developed species are found constantly assuming the same appearance; but in most cases the variety of outward form is so great that that feature in itself affords little aid in a systematic arrangement of the class.

By the kindness of Mr. Moore, of the Free Museum (whose unvarying courtesy in affording me at all times ready access to the collection under his care, as well as his valuable help in various ways, I desire to take this opportunity of acknowledging with sincere thanks), we have before us this evening

* *Grantia botryoides.*

a number of sponges selected as examples of varieties of form and growth, ranging from the *Isodictya Hyndmanii*, one of the species which is little more than a glairy glaze spreading itself on stones and shells, to the comparatively gigantic *Neptune's Cup*, weighing more than thirty pounds, and measuring four feet in height. Amongst them is the beautiful *Euplectella aspergillum*, or Venus's Flower-Basket, or perhaps more appropriately Bouquet-Holder; the *Pheronema Grayi*, like a nest anchored to the oozy ocean bottom by a beardlike arrangement of siliceous hairs; the *Hyalonema Sieboldi*, held up on a rigid glassy rope composed of a multitude of long spicules twisted together and spread out brushlike at the base where it is rooted in the mud or sand; the *Meyerina clavæformis*, with its delicately beautiful exterior lacework of spicules; together with many other interesting specimens.

General Character.

All sponges, whatever may be their outward form, possess in common that peculiar character which obtained for the Class the name *Porifera*. The skeleton is always internal, and the mass is always invested with a dermal covering ("investing membrane"), through numerous pores in which, water is admitted into the canal system which intersects it in all directions. Entering by the pores, the water passes through the branch canals into the main canals, and finally finds an exit through large vents.

The "investing membrane" in some species is of a most delicate structure, but varies from this to a leathery toughness; generally, however, it is transparent and colourless, and is resolvable again into sarcode when occasion requires. It is contractile, and has a controlling effect on the waterstream, whose current, entering through the pores in the membrane, is made to flow through the canals by the action of flagellate bodies situated on the sides of the water-

courses. The pores are not always permanent openings, but can be closed when circumstances require it, and Dr. Bowerbank's experiments show that, after a period of great activity, there is a period of rest, when the pores are closed, and the flow of the stream ceases until the pores are again opened.

In some groups, the "investing membrane" covers a body which consists of soft parts only, as in the *Halisarcinæ*, in which there is no trace either of spicules or fibre. In others, it covers a soft body with a rudimentary skeleton of spicules placed in it without apparent order and lying separate from each other. But in the greatest number of species the soft body is supported on a skeleton.

The Skeleton.

The skeleton is in some families of a beautiful and symmetrical design, in other cases no regular figure or pattern can be traced; and it varies from a fragile structure to a tough and elastic one, and even to a rigid and unyielding form.

The materials composing the skeleton are in some species produced *entirely* by the sponge, but in others only *partially* so. In the *Sponge of Commerce*, the skeleton is made up of horny elastic material; but in species nearly allied to it, plate II., fig. 2, it is made up of foreign objects, such as grains of sand and broken and disused spicules of other sponges, enclosed within, or, as in Dyseidea, simply cemented together by, similar horny material. In other groups it consists of spicules produced by the sponge, enclosed within or held together by this horny material, figs. 3, 4, and 5. But in the vitreous species, the skeleton is composed of siliceous spicules produced by the sponge, enclosed within siliceous material, and is then inelastic and rigid.

The mode in which the skeleton is formed or grows is not sufficiently known to be exactly described; but Mr. Carter has shown that the spicules found in it, originate in cells, and

the enclosing or cementing material clearly arises from the sarcode. "At the earliest period when a spicule becomes visible," Mr. Carter says (*Annals and Mag. Nat. Hist.*, 2nd ser., vol. xx., p. 24), "it appears under a hairlike form of immeasurable thinness, enclosed in a sponge cell of a spindle shape." Its origin and growth may be seen by developing the freshwater sponge (*Spongilla*) from the "capsules" found in it in quantities at certain seasons of the year, and the spicule is then found to increase from the "hairlike form" by the addition of layers of formed material accumulated around what *then* appears to be an elongated air-globule or air-cell.

Our knowledge of the way in which the material which cements together or encloses the spicules or foreign objects, is accumulated, is less definite; but it appears to arise from the sarcode, is deposited in layers around an axis, and seems to increase like the spicules by apposition from without. The objects found embedded in or held together by it, appear to be brought within the circle of this formation, probably by being passed to the outsides of the different protoplasmic masses, and become fixed skeletal parts, by the accumulation around them of this formed material.

Mr. Carter's observations, in 1857, of the movement of the growing spicules in *Spongilla* show that these objects are moved about much in the same way as hard objects, such as Diatoms, are seen to be passed through the sarcodous bodies of other Amœbalike animals. He noticed that "long before the spicules are formed, they are transported about from place to place by the sponge cells individually; and when too large for this, are twisted and turned and grouped by the sponge mass generally to meet the requirements of the case, with as much instinct as that which characterises the arrangement of bits of stick in an ant-hill, while they never appear to become fixed until the substance in which they may be embedded has altogether lost its vitality."

The Soft Body.

The soft body of the fully developed zoological individual consists of transparent and apparently structureless sarcode containing many granules, and of the flagellate bodies.

The granulous sarcode is considered by many German naturalists to be the result of the fusion or melting together of many nucleated cells, and in this respect is said to be like the Protoplasm of the Radiolaria and Foraminifera.

The late Professor Max Schultze stated that the Protoplasm of the Radiolaria results from the flowing together of many naked protoplasmic lumps with nuclei, the number of the cells which have melted together being indicated by the nuclei, and the run-together cells then act as did previously an individual or separate cell, or lump of protoplasm.

Professor Haeckel also, in his work on the Radiolaria, says that the sarcode of the Radiolaria and of the Foraminifera seems constantly to have its origin from many melted-together cells.

Dr. Oscar Schmidt states that in the embryo sponge, cells are undoubtedly to be found, but that, after it has wandered and settled, it does not consist of distinct cells, but is the run-together contractile contents of many cells with nuclei here and there, which are probably centres of new formation; and that the mass has then all the qualities of "unformed contractile substance," "sarcode," or "protoplasm," from which formed elements arise.

Lieberkuhn states that, although the margins of the cells cannot be distinguished, the apparently cell-less sarcode of *Spongilla* can be resolved into separate pieces by treatment with warm water; and other observations show that, in many species at any rate, the sarcode is made up of more or less distinct masses or naked cells.

The sarcode in some species possesses peculiar qualities;

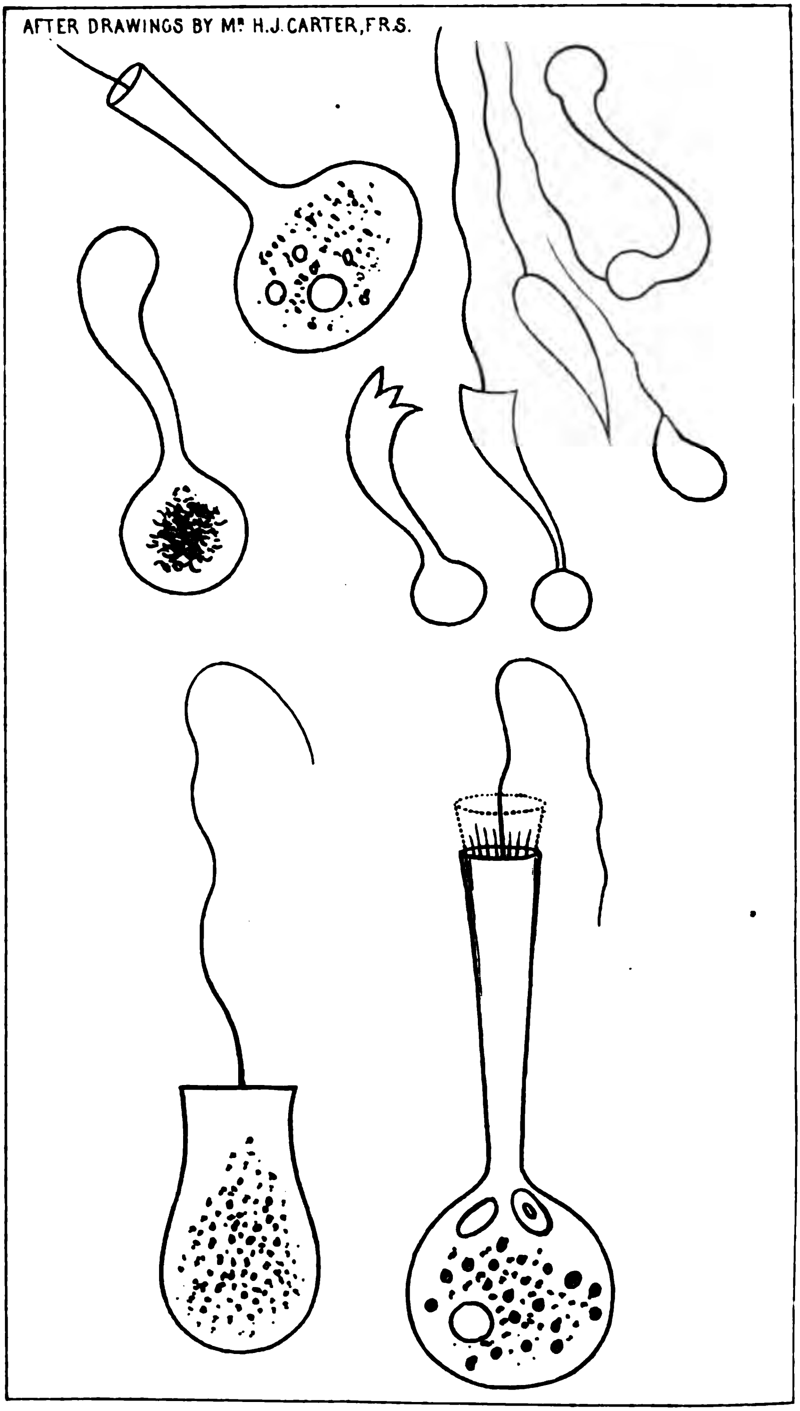


PLATE I.

Halichondria suberea (Johnston), found generally covering small shells, has the power of completely converting the calcareous shell to its own substance, and *Cliona celata* is found in circular channels drilled into masses of limestone as well as into shells. Opinion is rather divided as to whether the *Cliona* drills holes or not; but since the other species has the power of completely converting the entire shell, it is not more extraordinary that this species should be able to burrow into shells and limestone.

Urticating organs have not been found; but the presence of sponges has been noticed to be very injurious to the life of other animals confined with them. Dr. Bowerbank considered the death of other animals to be caused by the rapid exhaustion by the sponge of the oxygen; but Haeckel believes that a poisonous fluid is given off, because small infusoria were seen by him to be killed when they approached and touched the sponge mass.

The Flagellate Cells or "Spongozoa."

The flagellate cells, which cause the flow of the water-stream by means of which food is brought and refuse matter is carried away, are by artificial feeding found to perform the functions of digestion or change of matter.

If the living sponge be placed in a vessel containing water with which finely powdered indigo or other suitable substance has been mixed, the coloured particles are seen to be sucked in through the pores, and when the sponge is torn to pieces for examination under the microscope, it is found that the flagellate bodies have taken up and contain the granules of the colouring matter. Plate I. Details of this artificial feeding are given by Mr. H. J. Carter, Lieberkuhn, and Bowerbank, and, according to the experiments of the latter observer, the whole of the coloured particles are ejected within eighteen to twenty-four hours.

Of the students of the sponge organism, Dr. Oscar Schmidt alone objects to the conclusion that the flagellate bodies *only* perform the functions of change of matter. He thinks that the feeding experiments only yield negative results, and the whole of the unformed sarcode in his opinion performs the functions of assimilation; that "the sarcode regenerates itself perpetually, and supplies its loss of substance from outside, whilst formed materials arise from it."

As, however, the soft body of the sponge is found to be coloured *only* where these bodies exist, and it is seen that they contain the coloured granules, it is fair and reasonable to infer that the functions of digestion are performed by the flagellate cells, and to conclude that the sarcode is regenerated from the digested food or changed matter supplied by them. That, in fact, the extension of the organism from the embryo to the fully developed zoological individual is provided for by these flagellate bodies, which Mr. H. J. Carter has called "Spongozoa."

They were first found by Mr. Carter in 1857, in *Spongilla,* massed together in what he called "ampullaceous sacs," and he has recently found them in a similarly aggregated form in some marine sponges. The late Professor James-Clarke also found that they existed in groups, and found them to be so like the Flagellate Infusoria which he was then studying, that he declared the sponge to be a colony of flagellate infusorians. Exception has, however, been taken to this view, principally because in the sponge-cell he presumed the existence of an oral and an anal opening which could not be detected, whilst other observers found that the food was taken in in an amœbalike way.

Propagation.

The propagation of sponges takes place by sexual genera-

tion, and Professor Haeckel is of opinion that in the sponges examined by him it occurs in this way only.

Both in fresh-water and marine sponges, increase is seen to take place by means of ova. The development of the ovum is shown by Professor Haeckel in his recent work on the Calcareous Sponges; but it has lately been more fully described by Mr. H. J. Carter, in *Annals*, vol. xiv., pp. 321 and 389. He recognises it (the "ovule") at an earlier period, and records the changes occurring day by day until "a structure like that of the parent sponge has become fully developed." This, however, is not the first time that Mr. Carter has described the development of a sponge ovum. In 1857, his paper on the Ultimate Structure of Spongilla was published in the *Annals*. In it is fully shown, and very carefully figured, the development of the fresh-water sponge from the "seed-like body," with quantities of which at certain times it is found charged. The whole structure of *Spongilla* is there described and shown as it resulted from the contents of the "capsule," now known to be a true ovum.

Professor Haeckel believes that he has seen the impregnation of the ova by the spermatozoa, and has figured these bodies in the act of entering an ovum; but still he states that he feels no certainty as to the nature and distribution of the generative organs, particularly of the male element.

Lieberkuhn has described the spermatozoa of the *Spongilla*, and has found them enclosed in an envelope, which finally bursts, and allows them to move about freely until they come in contact with the ova.

Mr. Carter, however, states that he cannot be certain that he has seen the spermatic bodies. He has seen what may have been spermatozoa, but has not been able to identify them as such by seeing them enter the ova.

The "ovule," at the earliest period at which it has as yet been recognised, is found embedded in the sponge substance

or mass, and of a size very little larger than one of the flagellate cells. At this time, the yelk and nucleus only are visible; then the nucleolus and germinal vesicle are seen, the whole being enveloped in a layer of sarcode. Subsequently, duplicative division and sub-division takes place, and the ova are then found in every stage, from the first division until complete segmentation has occurred, and the embryonal state has at length been reached.*

Although first found embedded in the sponge mass, the ova soon appear adhering to the surfaces of the excretory canals, having probably reached that position by means of the layer of sarcode which surrounds them, or have been passed out by the general protoplasm. Here they are developed until they reach the embryo state, when they become ciliated, and finally pass out to commence life as independent organisms.

It is nearly fifty years since Dr. R. E. Grant found embryos in a specimen of *Halichondria panicea*, and by causing them to pass into watch glasses, observed that when they became fixed, the cilia by means of which they had moved about were withdrawn, and that they spread outwards so as to extend the whole substance into a thin transparent convex circular film, after which spicules were seen, and the existence of a waterstream became manifest.† At the same time, he noticed that when two ova settled so near as to touch each other, there was a complete coalescence of the substance of both, and they became one mass.

Dr. Bowerbank, also, in 1856 and 1857, experimented with embryos, and placed five close to each other, with a similar result; but it had been noticed by Cavolini, more than fifty years previously, that individuals of the same species, when brought near enough to touch, would grow together as one mass.

* *Annals*, Series 4, vol. xiv., pp. 321, 389.
† *Edinburgh New Philosophical Magazine*, vol. xvi., p. 121.

The sponge mass, therefore, which we find in the living state is sometimes a single zoological individual, but in other instances it is an aggregation or concrescence of two or more, sometimes even of very many such individuals.

Mr. H. J. Carter's recent observations, agreeing with those of Dr. Grant, show that the embryo is not entirely ciliated, but that at the obtuse end are found unciliated cells, which are provided for rooting purposes. The embryo attaches itself by these cells, after which the cilia of the ectodermal layer of cells disappear, and a change gradually takes place, resulting in a form and structure like that of the parent sponge.

In the case of *Halichondria incrustans*, it was found that this course of development occupied one week, in which time a skeleton had been formed supporting the investing membrane, and a vent was developed from what had been the apical end of the embryo.

On breaking up the structure at this stage, "the skeleton was found to be embedded in sarcode, which was charged with minute cells and granules, amongst which was observed the monociliated spongozoon, corresponding in appearance and measurement with the like in the parent sponge, which had been previously examined, measured, and sketched for reference."*

These flagellate bodies, together with the skeletal parts and the sarcode, are represented in the embryo. "When it is crushed, it is found to be filled with sarcode, charged with cells and granules of different sizes, together with the spicules of the species, the latter very delicate, and the larger cells filled with smaller ones, as if they were the commencement of the ampullaceous sacs which are so numerous in the

* *Annals*, Series 4, vol. xiv., p. 387.

perfected sponge."* On its settlement, the canal system, from the pores to the vent, is opened out, the flagellate bodies are developed, and by the change of matter effected by them the organism grows and increases until the full growth of the zoological individual has been attained.

Little is known as to the extent of growth of which a single zoological individual is capable, and its full size is only tolerably well seen in some species; but the observations of Mr. Carter indicate that in some sponges the skeleton spicules are all present in the embryo, from which it follows that when these have been fully developed and placed in position, the limit of growth has been attained.

The examination of some adult specimens leads to the same conclusion. Amongst the examples of *Euplectella aspergillum* in our Free Museum, are some which have been accidentally injured, apparently by fishermen's hooks, and, in one case, the rents so made in the skeleton have been repaired during the lifetime of the sponge. Plate II., fig. 6. It is a remarkable fact that this repair has not been effected by the reproduction of the large four-rayed spicules which form the groundwork of the meshes in the uninjured part of the organism, but it has been made good by a network composed of many threads of siliceous material, without the usual spicules. So that in this highly developed sponge, it appears that after the skeleton structure has been completely built up, new limbs so to speak, are not produced, but any repair which may become necessary is effected by a secretion of the formed material, which arises from the sarcode in which the general skeleton is embedded.

Nature of the Zoological Individual.

Professor Haeckel finds that the different functions of

* *Annals*, Series 4, vol. xiv., p. 383.

AFTER DRAWINGS BY Mr. H. J. CARTER, F.R.S.

1

APLYSINIDÆ.

3

CHALINIDÆ.

4

ARMATÆ.

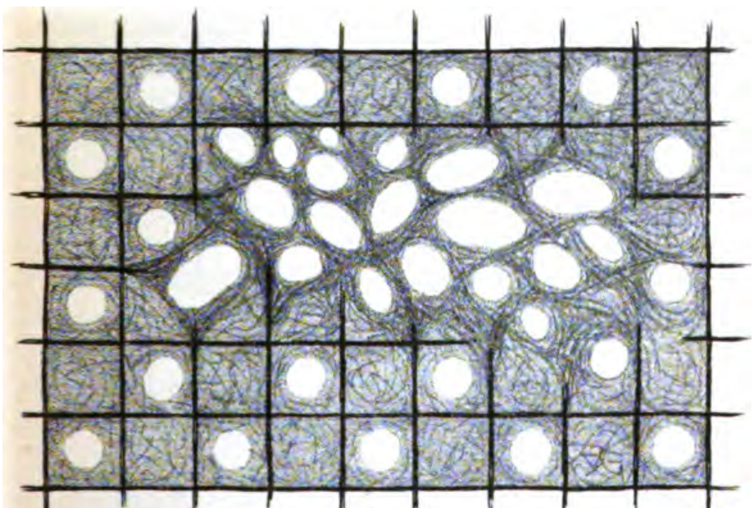
2

HERCINIADÆ.

5

RENIERIÆ.

REPAIR OF INJURY TO SKELETON OF EUPLECTELLA ASPERGILLUM.



6

AFTER A DRAWING BY T. HIGGIN.

PLATE II.

nourishment, which in the physiology of the change of matter of the higher animals are executed separately by different nourishment organs, as digestion, assimilation, absorption, circulation, breathing and separation, in the sponges are executed in common by the flagellate cells. He also states that both the masculine sperm-cells and the feminine egg-cells originate at different parts of the canal system by the separation of the flagellate cells, being in fact modified conditions of these cells.

According to the individuality theory laid down in his work on *General Morphology,* he recognises in the sponges "persons," and "stems" or "stocks," "*Prosopæ*" and "*Cormenæ,*" and agrees with Dr. Oscar Schmidt in regarding every osculum or vent with its surroundings as an individual. *

Dr. Oscar Schmidt considers that sponges are either simple or compound. Those sponges which have a single vent for the exit of the waterstream, he asserts, make the impression upon us at once that they are individuals, and he states that there is as much reason to consider them so as there is for regarding an *Actinia* or a *Medusa* as an individual. But in the shrub-like forms he sees colonies. †

Every osculum with its surroundings, he asserts, contains all the important parts of an individual, whilst the general sarcode is a bond of union, and consequently each vent is to be looked upon as representing an individual. The varied positions of the vents in different examples of the same species, sometimes scattered, sometimes congregated, sometimes in rows or ridges, and the *number* of vents found in a single zoological individual, offer to his mind no difficulty to the reception of this theory, because the conception of individuality in *all* the lower compound organisms is

* *Biologie der Kalkschwæmme,* p. 85.

† *Supplement der Spongien des Adriatischen Meeres,* 1864, pp. 16, 17.

very limited, and consequently, he asserts, it is not to be expected that the individuals of a compound sponge can be well defined. But the theory has not met with much favour from other Naturalists, and it is a matter of surprise that it should be put forward by Dr. Schmidt in 1864, and repeated and adopted by Prof. Haeckel in 1872, without any allusion to the observations of Mr. H. J. Carter, published in 1857, which show unmistakably that each vent can not be taken as representing a person. *

In his recent very interesting paper on the development of the marine sponges, already referred to, Mr. H. J. Carter argues that "if, as seems most probable, the ovum is put forth singly as the product of a single spongozoon, or in plurality as the product of its ovary, then the spongozoon must, *ipso facto*, be considered the expression of the sponge, in so far as it represents the stomach and the generative apparatus, aided by the rest of the body, which thus becomes analogous to such accessories in the highest animals, although the plurality of spongozoa scattered through the mass may more nearly resemble in this respect the flower-buds of a plant."

That part of the anatomy of the sponge which is now least known, and remains to be shown by future observations, is the position and distribution of the generative elements. If it be found, as seems most probable, that the flagellate cells put forth both the ova and the spermatic element, then all the prominence claimed by Mr. Carter for the "Spongozoon" must be given to this part of the organism, the remainder being accessory; and the nature of the zoological individual may then be considered to have been satisfactorily shown. It is neither a Rhizopod nor a Flagellate Infusorian, but has affinities with both.

* *Annals*, 1857, vol. xx. p. 31.

Classification.

Dr. R. E. Grant noticed, in 1826, the different varieties of skeleton, and suggested that a system of classification might be based on these differences—degrees of porosity and variety of outward form, the distinguishing features then recognised, being found deceptive. Two years afterwards, Dr. Fleming carried out the suggestion, and proposed an arrangement restricting *Spongia* to species having horny tubular fibre, giving the name of *Grantia* to calcareous-spiculed sponges, and *Halichondria* to siliceous-spiculed species, from which he separated *Tethea* (Lamarck), on account of the peculiar arrangement of the spicules of that genus. To these Dr. Johnston added *Spongilla* (Lamarck), *Duseidea* and *Halisarca* (Dujardin). Dr. Bowerbank followed, separating the Porifera into three orders— *Calcarea*, *Keratosa* and *Silicæa*, the two latter of which he divided, according to different characteristic forms of skeleton and internal structure, into seven sub-orders each, and taking the spicule form for specific distinctions, has in this way described two hundred and forty-six British species.

DR. BOWERBANK'S SYSTEM.

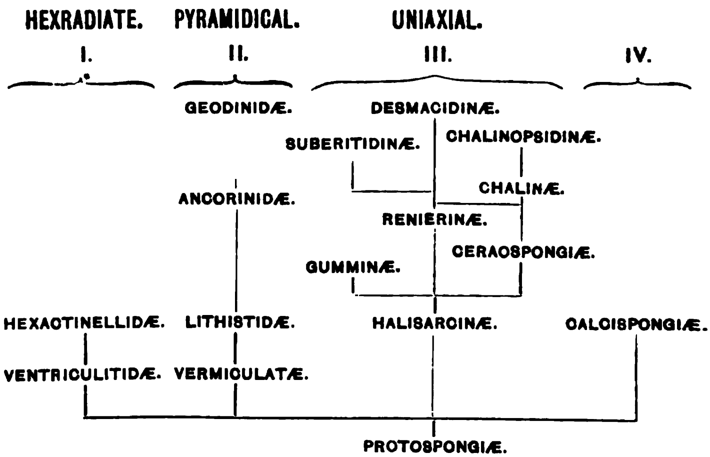
(*Mon. Brit. Spon.*, Vol. i., p. 159.)

CLASS.	ORDER.	SUB-ORDER.
PORIFERA .	I. CALCAREA.	
	II. SILICEA . .	Spiculo-radiate Skeletons.
		Spiculo-membranous Skeletons.
		Spiculo-reticulate Do.
		Spiculo-fibrous Do.
		Compound Reticulate Do.
		Solid SilicEo-fibrous Do.
		Canaliculated Siliceo-fibrous Skeletons.
	III. KERATOSA	Solid Non-spiculate Kerato-fibrous Skeletons.
		Solid Semi-spiculate Do. Do.
		Solid entirely Spiculate Do. Do.
		Simple Fistulo-fibrous Skeletons.
		Compound Do. Do.
		Regular Semi-areno-fibrous Skeletons.
		Irregular and entirely Areno-fibrous Skeletons.

Dr. Oscar Schmidt has during the last ten years published several treatises on the sponges of the Adriatic sea, the coast of Algiers, and the fauna of the Atlantic ocean, naming many new species, and re-naming many old ones. He groups sponges on a different system, not very definitely explained, but proposes the division of the siliceous-spiculed sponges, according to certain types of spicule form, into three orders, which he terms *Uniaxial*, *Anchor-formed* or *Pyramidical*, and *Hexradiate*, and expresses the opinion decidedly that degrees of skeleton formation, as well as modifications of the canal system, are of small importance. In this statement, he is supported by the Russian Naturalist, *Miklucho-Maklay*, who considers that the attempt to divide the *Halichondriæ* according to gradations of horny formation is a failure, and that the grouping of species upon this conception is quite untenable.

DR. OSCAR SCHMIDT'S SYSTEM.

(*Spongien-Fauna des Atlantischen Gebietes*, p. 63.)



The same "spicule-complement" is found in sponges which have very different forms of skeleton, and it is scarcely

possible to avoid the conclusion that, in such cases at any rate, *spicule complement* rather then *skeleton form* must be considered to be the character of first importance in attempting a classification.

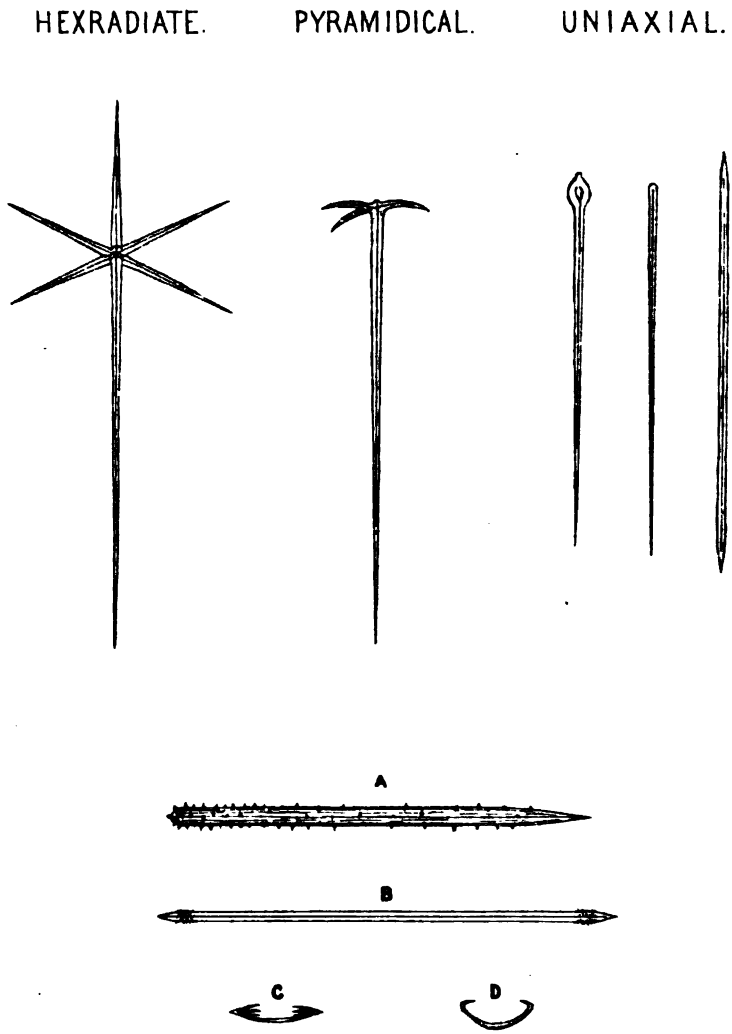
A remarkable instance of this similarity of spicule complement with diversity of skeleton form has lately come under my notice, in two sponges given me with some others by Mr. Laurence Hardman, of Rock Ferry. In each the spicule complement is that of *Halichondria incrustans* of our own coasts, but the skeleton form varies very much. In the British example, the skeleton is a loose network of spicules, with scarcely any horny material; in the sponge from the Falkland Islands, it is fibrous, composed of the "spined acuates" embedded in horny material; whilst in the example from the West Indies the skeleton is also fibrous, but it bristles all over with the "spined acuates." These sponges, therefore, which from this point of view are varieties of the same genus, if not of the same species, would, according to the hitherto accepted method of classification, be placed in three different sub-orders, and would thus increase the number of genera and species.

The examination of these and other similar cases leads to the conclusion that some localities are more favourable for the production of horny material than others; and this brings us to a question which has as yet not received any consideration, namely, What are the local circumstances which exercise a modifying effect on skeleton form? Are we to look for them in the chemical constituents of the surrounding element, or in the nature of the ocean bottom, or in the temperature of the ocean, or in a combination of these and other causes?

The calcareous-spiculed sponges naturally separate themselves from all others; and in no instance are they found to become in any way confused with the horny-fibred

or siliceous-spiculed sponges by an admixture of skeleton material. Their skeletons are never made up of any but calcareous spicules, nor are calcareous spicules ever found in other groups. They therefore isolate themselves so far as skeleton is concerned, and form a distinct primary division of the class. Dr. Bowerbank separated them into four genera, *Grantia*, *Leucosolenia*, *Leuconia*, and *Leucogypsia*. Professor Haeckel, in his recent Monograph, divides them into three orders: 1. *Ascones*, those which have hole-like canals. 2. *Leucones*, those with branch canals; and 3. *Sycones*, those with radiate canals. And these he sub-divides into twenty-one genera, comprising a hundred and eleven species.

The calcareous sponges offer no great difficulties as to arrangement; it is the horny-fibred and siliceous-spiculed ones which are found difficult to classify, because they pass in the most gradual way from the purely horny-fibred species to those whose skeletons are made up almost entirely of siliceous spicules. First, grains of sand and other objects are found embedded in the horny material; then, associated with these foreign objects, are spicules produced by the sponge; then gradually the spicules become more abundant, and the foreign objects disappear; and again the horny material diminishes, until at last it is completely absent. This gradual passage from the distinctly horny fibre to the siliceous fibre has induced Dr. Oscar Schmidt to declare that the sponges which produce horny material only, cannot be contrasted with those producing both horny and siliceous material as distinct orders, and has led him to look for a more stable feature, which he thinks to have found in spicules of the *Uniaxial*, *Pyramidical*, and *Hexradiate* types. But one cannot look at these different forms without seeing quite as gradual a passage from one to the other as in the skeleton form. The acerate becomes acuate, and the acuate becomes spinulate, and the spinulate puts out rays, and becomes



SPICULES OF HALICHONDRIA INCRUSTANS.

JOHNSTON.

C *and* D *much more highly magnified than* A *and* B.

PLATE III.

anchor-formed or Pyramidical, and the Pyramidical passes easily to the Hexradiate, Plate III.

Some siliceous sponges do, however, separate themselves from the rest. The Vitreous Hexactinellidæ have skeletons composed of siliceous spicules not cemented together by horny material, but held together by or embedded in, siliceous material, and these sponges therefore may *par excellence* be considered as siliceous sponges.

Prof. Haeckel's Proposal.

Professor Haeckel has proposed the separation of the whole class into three primary divisions.

I. *Calcispongiæ*—Calcareous sponges.
II. *Fibrospongiæ*—Sponges with skeletons.
III. *Myxospongiæ*—Sponges without skeletons.

There are but few species which are without skeleton, and the *Calcispongiæ* separate themselves very distinctly from all others, are of small size, and are easily recognised. The bulk of sponges therefore come under the second order, *Fibrospongiæ;* and the first division of this group is *naturally* into sub-orders having reference to the materials composing the skeleton, which are produced by the sponge. All sponges then which produce horny material *only* for skeleton purposes, no matter what foreign objects they take up, would come under

Sub-order 1.—*Keratosa* (Bowerbank in part).

Those which produce both horny material and siliceous spicules, though they may also take up foreign objects, would come under

Sub-order 2.—*Kerato-Silicea.*

And those which produce siliceous spicules and amorphous siliceous cementing material would come under

Sub-order 3.—*Silicea* (Bowerbank in part).

Outward form being variable, and *skeleton form* as well as *modifications* of the *canal system* being also variable, *spicule form* and "*complement*" would seem to be the features deserving most consideration in the separating of these *Sub-orders* into *Families, Genera,* and *Species.*

PROPOSED ARRANGEMENT.

(EXTENSION OF HAECKEL'S PRIMARY DIVISION.)

- SPONGIDA.
  - CALCISPONGIÆ (HAECKEL).
  - FIBROSPONGIÆ (HAECKEL).
    - KERATOSA (BOWERBANK IN PART). PRODUCING FOR SKELETON PURPOSES HORNY MATERIAL ONLY.
    - KERATO-SILICEA. PRODUCING FOR SKELETON PURPOSES BOTH HORNY MATERIAL AND SILICEOUS MATERIAL.
    - SILICEA (BOWERBANK IN PART). PRODUCING FOR SKELETON PURPOSES SILICEOUS MATERIAL ONLY.
  - MYXOSPONGIA (HAECKEL).

MR. CARTER'S PROPOSED ARRANGEMENT.

Mr. H. J. Carter has been engaged for the past few years upon the sponges in the British Museum, and every single specimen has now been carefully examined by him. As the result of this laborious work, he has proposed to separate the whole class into five groups, which will include all sponges, whether without skeleton, horny fibred, siliceous fibred, or calcareous. See Plate II., figs. 1–5. He has named them—

I. Aplysinidæ. Sponges with horny fibre and granular axis, *without* foreign objects.

II. Herciniadæ. Sponges with horny fibre, amorphous sarcode, and axis of foreign objects.

III. Chalinidæ. Sponges with horny fibre and axis of proper spicules only, that is, spicules formed by the species.

IV. Armatæ. Sponges with horny fibre and axis of proper spicules, more or less echinated also with proper spicules.

V. Renieriæ. Sponges in which the fibre is formed of proper spicules cemented together by amorphous sarcode.

He has announced that he is now writing an Introduction to the Study of Sponges with a Classification, and until it appears we shall not know his complete system. The names and characteristics of his five primary groups are all that he has yet published; and although one may not see very clearly at present how he will bring many of the sponges within the terms of these groups, his life-long study of these and kindred organisms, together with his extended knowledge obtained from the examination of an enormous number of specimens from all parts of the world, eminently fit him to take a comprehensive view of the whole class, and we may expect that the system to be proposed for the national collection will be one that can be adopted in the arrangement of our local collection.

Conclusion.

We cannot but be much impressed in noticing the marvellous vital phenomena exhibited by this low animal organism. In some species we see the inexplicable power of selecting from the ocean debris objects suitable for weighting or strengthening, or it may be *for producing*, the skeleton form; for these objects, when selected, are moved about and are designedly placed in position to be worked into the skeleton. We cannot know with certainty perhaps for what purpose these foreign objects are introduced; but we find that the horny material or siliceous cementing material is always accumulated round an axis of some kind, whether it be an air-globule or air-cell, granules, grains of sand and

other foreign objects, or spicules produced by the sponge; and the explanation of this may be, that these objects become *irritants* which cause the sarcode to secrete the formed material which binds them together in a continuous network, and so produce the skeleton. In the humbler forms, there is an absence (apparently to our sight) of pattern and design in the skeleton; but in the more highly developed species, by this simple organless protoplasm, is built up a skeleton structure which is a very marvel of regularity of form and beauty of design; and we rise from the study of sponges with a deep feeling of reverence for the great Author and first Cause of these manifestations of vital force, and with a profound sense of the mystery of life, which we cannot fathom and are unable to explain.

THE YANG-TSE-KEANG RIVER OF ASIA.

BY RICHMOND LEIGH, M.R.C.S.

IN the years 1872–3 I paid two visits to China, on the second of which I ascended the great river Yang-tse-keang for six hundred miles, *i.e.* to Hankow, the limit to which foreign vessels are permitted to proceed. Though my sphere of observation was but very limited, I was greatly struck by the immense size of this, perhaps, the largest of all rivers, of which at the same time so little, comparatively speaking, is known among us, and by its vast commercial importance.

The portion that I myself visited being but a small part of the whole river, I have consulted the works of the few travellers, especially those of Messrs. Huc and Gabet, and De Carne, who have visited the comparatively unexplored regions in which the Yang-tse takes its rise, and through which it flows for the upper part of its course.

This vast river, one of the largest, if not *the* largest, in the world, rises between the 34th and 35th degrees of north latitude, in the Kuenlun and Nanshan range of mountains to the north of Thibet, where it approaches the origin of the Brahmapootra and Hoang-ho rivers.

It traverses a portion of that elevated region, and the most fertile and central part of China, and after a course of over three thousand miles debouches into the part of the North Pacific Ocean, termed the Yellow Sea. This sea owes its colouration to the influx into it of this river, and another great sister river, the Hoang-ho, which rises in close proximity to it, and after a thousand tortuous windings empties itself into the Yellow Sea within a few miles of the mouth of the Yang-tse. The yellow, or rather tawny, colouration is produced by an

enormous amount of alluvial matter which is held in suspension by these two rivers. As this suspended material gradually settles, it is continually forming new shoals, banks, and islands, and gradually changing the outline of the coast. Mr. Fortune mentions an island that in 1843 was a sandbank barely visible at high water, while in 1857 it was covered with trees, inhabited, and formed an excellent mark to navigators. The town of Kanpoo was the great seaport of Hang-chow-foo, in the time of Marco Polo; whereas, now, the alluvial deposits of the Yang-tse have destroyed its maritime importance, and converted it into an unimportant inland town.

The Yang-tse-keang, literally "son of the sea river," or, as it is called by Europeans the "Blue River," is more like an arm of the sea for some distance from its mouth. In this portion its width varies from five to ten or fifteen miles or more, and, the land on either side being very low, frequently only one bank is visible at one time. This low and very level land extends many miles from the sea coast, and has evidently been formed by the deposits of the river. Its level and alluvial character renders it well fitted for cultivation and irrigation, a quality that is fully appreciated by the Chinese, who inhabit this region very thickly, and cultivate it highly, growing large quantities of rice, for the production of which it is peculiarly fitted, besides other crops, as cotton, cereals, beans, etc.

At its mouth the river is twenty-one miles in width, and in its middle lies the alluvial island of Tsoong-ming, about thirty miles in length, but of no great width. This island is also called, from its position and shape, Keang-she, or the tongue of the river.

Proceeding up the river, a large branch, the Woosung, is soon reached, on which is situate the town of Shanghai, now by far the most important port in China. It has obtained

this pre-eminence from its position, being the largest town near the mouth of the Yang-tse, through which it commands the vast extent of country drained by that river. Vessels of the largest size can reach this port at all periods of the year. It contains English, French, and American (U.S.) settlements, besides numerous representatives of other nationalities, there being a total of about four thousand Europeans in the place. The native town is quite separate from the European (though many Chinese have settled in the latter, especially the French quarter, which is nearest their town), and consists of many narrow winding dirty streets of houses and shops enclosed by a rough wall.

The branch of the Yang-tse on which it is situated, though of no great length, is yet of considerable size, being three-quarters of a mile in width opposite Shanghai, and for some fifteen miles above that town, which was as far as I ascended it.

Leaving this branch, and ascending the river, the land on either side continues to present the same flat and alluvial character for many miles, with but little variety in scenery. About one hundred and twenty-five miles from its mouth is situate the town of Chinkeang, a port of considerable importance, where all European boats passing have their papers examined. That immense commercial thoroughfare, the Grand or Imperial Canal, joins the river here on either side, extending on the south to Hangchowfoo, and on the north to Pekin, a distance of about a thousand miles.

From here to Hankow the country is more or less hilly, and the land much less cultivated than in the more level portions. The river varies greatly in breadth, being at times as much as five or six miles in width, and giving a fair horizon for determining the latitude, while in other places, when narrowed by rocks, etc, only some five hundred yards. There are many important towns on the river, chief of which

is Nanking, which was the second city in the empire until it was destroyed by the Taeping rebels, in the late war, who also pulled down its celebrated porcelain tower. It was surrounded by a wall of such extent that it was a day's journey to encompass it. But it must be here remarked, that the wall of a Chinese town includes large spaces of uncovered ground, the object of which is that it may afford a place of refuge for the inhabitants not only of the town, but of the surrounding country, in time of war.

There are numerous other towns on this portion of the river, among which may be mentioned Nganking and Kiukiang, the latter having a European settlement. No branch of any great size enters the river in this part of its course, but it communicates with a very large lake, the Poyang, some hundred and sixty miles below Hankow. This lake is variously stated as fifty to seventy or more miles in length, by about fifteen in width, and receives one large, and many smaller streams. It is navigated in every direction by junks and smaller boats.

The river, in the part we have now traversed, repeatedly divides into more than one or two channels, which are often of equal size, and used in the same proportion by vessels.

The extreme limit of that part of the Yang-tse at present open to European commerce lies at Hankow, a place of which the French traveller, Du Halde, wrote—"it is like the centre of the whole empire, the place from whence it is most easy to visit the other provinces;" and again, "it is the most populous place in China."

"Doubtless, in viewing only the forest of masts which border that noble river, the Yang-tse, about a league in breadth at such a distance from the sea, there is sufficient ground for admiration; but if, on mounting some height, one comes to discover the vast tract all covered over with buildings, one scarcely believes one's sight, or at least one

believes it to be the finest thing in the world of its kind." This language is no doubt a little exaggerated, but nevertheless, the conglomeration of human habitations at this point, where the river Han joins the Yang-tse, is wonderful. Hankow itself is no inconsiderable place; and on the opposite side of the river lies Woochang; while, separated from Hankow by the river Han, is situate Han-yang, both of which latter towns are of great size. As M. Huc says, "these three towns, standing in a triangle, form a kind of heart, from which the prodigious commercial activity of China circulates to all parts of the empire. They are—or rather were at the time of his visit—calculated to contain together nearly eight millions of inhabitants, and they are so closely connected by the perpetual going and coming of a multitude of vessels, that they may be almost said to form one. This is the spot that must be visited by those who would wish to have an idea of the internal trade of China. Hankow is one great shop—the port is literally a forest of masts. It is in some measure the general mart for the eighteen provinces. Perhaps the world could not show a town more favourably situated, and possessing a greater number of natural advantages. Placed in the centre of the Empire, it is in some measure surrounded by the Blue River, and brought into direct communication with the provinces of the east and west. This same river, on leaving Hankow, describes two great curves to the right and left, and bears the great trading junks towards the south, as far as the lakes Poyang and Tongting, which are like two inland seas. A number of rivers which fall into these two lakes serve to bring and take away in boats the merchandise from and to the provinces to the south. Towards the north the natural communications are less easy, but gigantic and ingenious labours have come to the aid of nature, in the numerous artificial canals with which the north of China is intersected, and which by marvellous and skilful contrivances

establish a communication between all the lakes and navigable rivers of the empire, so that you might traverse its entire extent without ever getting out of your boat."

The population of these three great towns has been variously estimated, by some as high as eight millions. It was greatly diminished by the attacks of the rebels in the late war, and probably amounts at present to about three millions. There is a very important European settlement here, which presents a very good appearance from the river, on the edge of which there is a fine "Bund," or promenade, lined with noble villa residences of the merchants. A great part of the tea produced in China is disposed of in this town, making it a port of great importance. In the season, when the new spring teas arrive, the bustle and activity of the town is enormous. Numbers of large tea junks continually arrive and discharge their cargoes, which are again carried on board the fleet of steamers that are always awaiting them. Day and night the turmoil continues, till the town resumes gradually its ordinary and still active state of business.

Beyond Hankow—the limits of my personal visit—the river extends through the central part of China to Thibet. In this position it traverses the provinces of Hupeh and Sce-tchouen, as well as a portion of the mountainous province of Yunan. The province of Sce-tchouen M. Huc calls the largest and perhaps the finest province in China. Its fertility is such that it is said the produce of a single harvest could not be consumed in ten years. Various crops are produced in this province, among which may be mentioned tea, hemp, indigo, wheat, and other cereals. Even in this part of its course, nine hundred miles from its mouth, the Yang-tse is already a league broad, according to M. Huc. The great Tong-ting lake communicates with the river, some distance above Hankow. This vast lake, said to be three hundred miles in circumference and of great breadth, is more like an

inland sea than a lake. It receives several rivers and numerous smaller streams, and, like lake Poyang, is navigated in every direction by boats of all sizes.

For the greater part of its extent through these provinces, and for the remainder of its course down to its mouth, the Yang-tse has a very even and uninterrupted course. This is a great advantage in a commercial point of view, for it renders it navigable without any break for probably upwards of eighteen hundred miles from its mouth, a capability which I believe is not nearly equalled by that of any other river. The great central plain of China through which it runs, and which slopes gradually down from the mountainous region of Thibet, has such a small inclination, that it permits the river to have a continuously even course down to its mouth, and also causes the current to be but slow for the greater and terminal portion of the river.

The nearer we approach to Thibet, the more mountainous does the country through which we pass become, attaining its climax in the wild and elevated province of Yunan, which stretches up to the eastern extremity of the Himalayas.

Some miles above I-chang-fou, or about four hundred miles above Hankow, the mountains approach so closely as to form a gorge, and for a short distance the river foams and roars in a somewhat contracted bed, but this does not prevent junks of large size passing without much difficulty.

Twelve hundred miles above Hankow, or eighteen hundred miles from the sea, is the town of Pinshang, the extreme point reached by the English expedition under Colonel Sarel, who was compelled to abandon his enterprise at this place, the country beyond being in a state of rebellion and anarchy. M. de Carne thus describes this part of the Yang-tse, eighteen hundred miles from the sea: "An immense river, whose waters, at each instant increased by the tribute of innumerable affluents, are ploughed by fleets of junks." These

affluents themselves are of no inconsiderable size, M. de Carne having sailed for some distance in one before entering the Yang-tse. From this point he descended uninterruptedly to the mouth of the river.

Above Pinshang, there are interruptions in the navigability of the river, but still numerous vessels are found on it. At Manko, some two hundred and fifty miles higher up, M. de Carne, with his party, crossed the river in a large ferry-boat, and, on sounding the depth of water, a sixty foot line did not touch the bottom. The country, though very mountainous, is delightful here, and very productive in the valleys, where, amongst other crops, sugar canes were growing. After crossing a mountainous tract contained within a bend of the river, M. de Carne again met the waters of the Yang-tse, at the point where it first takes that name, being formed by the junction of the Pe-Shoui (or Ya-long) and Kincha rivers, the latter being the larger and main branch and proceeding westward, the former passing to the north. This latter division (the Kincha) was followed by M. de Carne for a short distance, to the point where it approaches the mountain lake of Tali, one of the sources of the great Mekong river of the Siamese peninsula. Here, two thousand two hundred miles from its mouth, the river is still of large size and navigable for large boats. This is the highest point reached by a European, except a place nearer the origin of the river in north Thibet, where it was crossed by MM. Gabet and Huc, thus leaving a distance of over a thousand miles of its course almost entirely unexplored.

The river Kincha runs for some distance on the border of China and Thibet, its course becoming gradually more rocky and irregular; then leaving China it passes along the north of Thibet, and probably takes its rise in the Kuenlun and Nan-shan mountain range. Nearer its origin, the Kincha-keang, or river of golden sand, assumes the name of Mouroui-

Oussou, or tortuous river. MM. Gabet and Huc passed the frozen river under the latter name, and there witnessed the curious spectacle of some fifty wild cattle absolutely encrusted in the ice, while attempting to swim across. This spot, where the river is still of considerable size, was several days' journey above the origin of the Hoang-ho, and probably about longitude 94° E., and I should consider quite three thousand miles from the sea, by the course of the river.

A little eastward of this, the Yang-tse approaches the origin of the Hoang-ho, being merely separated from it by the Bayen-Kharat mountain range. The slight notice of it by M. Huc is the only information we have of the Yang-tse near its origin, which I fear will not be reached by travellers for some time yet, owing to the wild robber tribes that infest these mountainous regions. The actual site of the source of the river is veiled in obscurity. It is presumed to take its rise in the Kuenlun range, but from a recent note by Captain Chapman, R.A., of Sir T. Douglas Forsyth's expedition, it seems possible that it may arise in the mountains forming the western boundary of Turkestan and Thibet. According to his statement, "the western side of Kashgar and Yarkund is bounded by a vast ridge, called the Pamir and Bolor Dagh, which is the true watershed of Asia, sending down the Oxus and Yaxartes rivers (Amoo and Syr Daria) to the sea of Aral on the one side, and the rivers flowing towards China on the other, as well as the Indus, which flows to the Southern Ocean. Until the present year (1874), the Pamir, which has been deemed the highest mountain plateau in Asia, was little known to European Geographers."

On account of the robber tribes infesting these regions, MM. Gabet and Huc had to wait eight months for the return of the great Thibetian Embassy from Pekin, with which great company they travelled for a great part of their journey to Lhassa, as it would have been certain death to proceed

without them. In the elevated regions through which they passed—compared to which the Alps are trifles—the cold endured by our travellers was so intense, that some forty men of their caravan had to be abandoned, having been reduced to such a state as to render them helpless and their recovery hopeless. Crows and vultures incessantly hovered above the caravan, and as soon as the last straggler had passed, would pounce down upon the poor wretches left behind, who retained just sufficient life to feel themselves torn to pieces by these birds of prey. Those that survived had the greatest difficulty in keeping life within them.

The present great obstacle to travel in these parts, and in China, is the peculiar distrustful and pusillanimous character of the inhabitants, especially the Chinese, who would hinder the traveller from doubt of his object, oppress him if strong enough, cringe before him if master, and all the while cheat him on every hand. Charts and maps have a special effect upon these nations; as M. Huc remarks of the Thibetian Government, "they inspired them with excessive fear," of plans for attacking their country.

MM. Gabet and Huc studied the language of Thibet for many months, and assumed the Lamanesque costume to be able to travel without hindrance in this country of Lamas. They succeeded in reaching Lhassa, which but few Europeans have done, amongst whom may be named Moorcroft, who, under the disguise of a Cashmerian shepherd, lived in the town twelve years, but was unfortunately assassinated by brigands on returning to Ladak. Although MM. Gabet and Huc succeeded in reaching this town, they were not allowed to continue their journey to Calcutta, but were compelled to return all the way back to Shanghai, through the suspicion of the Chinese agent at Lhassa.

The elevated plateau of Thibet consists of numerous mountain ranges, with intervening valleys, which traverse

the country in nearly every direction, between the Kuenlun and Nanshan range on the north, and the Himalayas on the south. The highest point reached by MM. Gabet and Huc was the summit of the pass of the Tant La mountain range, to the south of the Monsoni-Ousson, which M. Huc calls "probably the most elevated spot reached by travellers."

Unfortunately he and M. Gabet were not scientific travellers, not even taking the altitudes of the ranges over which they passed, which renders it difficult to fix the height of this pass. The snow here appeared to them permanent, "an incrustation, an ordinary portion of the soil." If this was the case, the elevation would probably be not far short of twenty thousand feet (a height exceeding that attained by any other traveller, I believe), as the line of perpetual snow on the north side of the Himalayas is stated as twenty thousand feet by Dr. J. Hooker. The mean height of this great plateau—not plain—of Thibet is over eleven thousand feet, a height which would be uninhabitable to the millions who dwell there but for its peculiarly fine climate, and from the rarity of the formation of the snow in the dry atmosphere. (Humboldt.) This reacts on the Himalayas, the heat radiated from the plateau raising the snow-line to twenty thousand feet on the north, as against fifteen thousand on the south side. On the north of this mountainous and elevated region, the Yang-tse river takes its rise near north latitude 35°, and, after traversing part of Thibet, enters China, receives the Peshoni, and, becoming named the Yang-tse, runs through the central part of that country to the sea.

Rising in close proximity to the Yang-tse, and merely separated from it by the Bayen-Kharat mountains (at its upper part), is the great Hoang-ho, or Yellow River, running in the same general direction, sometimes approaching near to, and sometimes widely diverging from it. It resembles the Yang-tse in the evenness of its flow, its inundations, and

the large amount of matter held in suspension by it. The basin through which it runs is separated, at the higher, interior or western part, by the Chensi, Peling, and other mountain ranges, but at its lower and eastern part it joins that drained by the Yang-tse, the portion between the two rivers forming an immense fertile plain, traversed by numerous canals. The two gradually approach one another, until, at their mouths, they are only separated by about two degrees of latitude. For a great part of its course the waters of the Hoang-ho are almost level with the lands through which they flow, and through this circumstance occur those inundations so disastrous to the Chinese. Its course has undergone numerous and notable variations. In ancient times its mouth was in the Gulf of Petcheli, in north latitude 39°, at present it is in the 34th parallel.

The Chinese government is compelled to spend enormous sums in keeping the river within its bed, and preventing inundations. In 1779, the embankments for this purpose cost no less than £1,600,000. Yet, despite these precautions, inundations are of frequent occurrence, for the bed of the Yellow river, in the provinces of Honan and Keang-sou, is higher than the plain through which it passes for two hundred leagues. This bed continuing to rise with the quantity of sand deposited, there is inevitably impending, at no remote period, an awful catastrophe, involving destruction of life and property in the adjacent districts.

The Yellow river owes its colour to the great quantity of sand that falls into it from the Alechan mountains, a long chain composed of mobile sand, so fine that when you touch it it seems to flow through your fingers like a liquid. Above these mountains the river is clear and limpid. (Huc.)

Like the Egyptian Nile, this river and the Yang-tse have their periods of increase and overflow, which occur during spring, and owe their origin mainly to the melting of the

snow on the mountains of Thibet, etc., and, in a less degree, to the periodical rains of the country. The rise of the Yang-tse begins very gradually, and increases in amount, until towards the latter end of May it rises at the rate of from half a foot to ten inches or even a foot or more per diem. At Hankow, the total rise varies from thirty to fifty feet, flooding the city itself when near the latter figure, and compelling the inhabitants to go about in the canoes with which they are provided. Even an ordinary rise floods many thousand acres of land, and prevents their being cultivated as they otherwise would be, while a high rise causes immense damage to the Chinese farmers.

When the increase is at its height, the country round is covered for many miles with water, and the track of the river lost in the general overflow. This increase of the water of the river serves a very good purpose, in permitting ocean-going steamers of the deepest draught to ascend at this time, whereas at other times the depth of water in parts of the river is too shallow to allow of their doing so. As the flood time is also the time of the arrival of the first teas of the season, it proves especially convenient and serviceable.

The climate of the lower part of the valley of the Yang-tse is very extreme in character. In summer the heat is excessive, much greater than further south; the thermometer frequently, in fact generally, in the hottest part of the summer, rising above 100° Fahr. in the shade, while in winter frost appears for a short period, and is felt doubly from the previous heat. The diurnal variation of temperature is usually considerable, frequently amounting to more than fifty degrees. Notwithstanding these drawbacks, the country is a healthy one for Europeans as a rule, the cold winter season serving to brace them up between the hot summers, during which it is only for about three months, June, July, and August, that the heat is excessive.

The valley of the Yang-tse, being in such a high state of cultivation, and so densely populated, is not particularly rich in flora or fauna. As far as I myself observed, there were no forests, or even woods, and single trees of moderate size were scarce, the Chinese farmers appearing to think that they interfere too much with the productivity of the land. Higher up the river, in the mountainous province of Yunan, etc., there are immense pine forests, which are gradually being cut down, without any planting of young trees, so that they will sooner or later disappear.

There is a great abundance of game birds and animals—deer, wild boar, hares, pheasant, snipe, etc., in this valley, as but few Chinamen know how to shoot, and fewer practice shooting game, which they never eat, although they take the trouble to collect snails, frogs and other small animals for edible purposes. From the marshy character of a great part of the country, numbers of herons and other wading birds are met with.

The river Yang-tse varies greatly in breadth from its mouth to Hankow. An average would probably make it two miles in width, the actual variation being from about four hundred yards to twenty one miles, the width of its mouth. Its length is frequently stated to be two thousand four hundred or two thousand five hundred miles, but from my own examination of what information I could obtain on the subject, I believe the river to be over three thousand miles in length. M. de Carne crossed the river, still in China, two thousand two hundred miles from its mouth; and from this point to its origin in the Kuenlun range I estimate at quite a thousand miles. This would make a total of three thousand two hundred miles or more, which I believe to be nearer the truth than the length ordinarily given. In size, I am inclined to believe it the largest river in the world. It is generally conceded that the Amazon is the largest. Referring to a work of Humboldt,

who having visited and carefully observed ought to be well able to judge, I find that, in comparing the great rivers Amazon, Orinoco, and La Plata of South America, he is inclined to the opinion that the Orinoco is the largest, having regard to its volume of water; and that in this decision he leans very much on the fact that he had met the latter in the interior of Guiana, five hundred and sixty miles from its mouth, three and one-third miles in width. (*Aspects of Nature.*) The Yang-tse is frequently this breadth at from one thousand to fifteen hundred miles from the sea, a distance equal to the total length of the Orinoco. M. de Carne calls it "an immense river" at Souitcheou, eighteen hundred miles from its mouth, and at Manko, about two thousand and fifty miles from the sea, a sixty foot sounding line did not touch the bottom, at the point where M. de Carne chanced to cross. These facts shew that, if not absolutely the largest, the Yang-tse is still one of the largest rivers in the world.*

This river frequently divides into several channels of large size, often large enough for deep-draught steamers (twenty feet and upwards—the steamer in which I descended the river from Hankow drew nearly twenty-four feet of water), beside smaller ones, and to such an extent that in some parts it forms a vast network over a large space of country.

The convenience of the river as a means of transport is thoroughly appreciated by the Chinese, the number of native craft on it being legion, many thousands of families living altogether on the water. Large rafts of timber, with numbers of huts on them like small villages, are seen slowly floating down from their native interior forests. Stranger than these

* The volume of water contained in the Yang-tse, Amazon, and other tropical rivers varies very greatly at different periods of the year, and until these variations are correctly stated, it will be an impossibility to compare these rivers with regard to size. In this paper, the measurements given are at the time when the increase of the river is considerable, though not at its height.

are the floating islands, which are met with higher up the river. They are constructed of bamboo, which is very buoyant and long resists the action of water, on which a quantity of soil is placed and crops are reared, by families living on the raft. They move up or down the river and lakes as inclination leads them; ascending the river being, however, very tedious for such cumbrous craft as these.

The Chinese always prefer to use water as their means of locomotion, which is not to be wondered at, seeing they have but few roads, and those in a bad state of repair; while all the land transport of the country is done on men's shoulders and beasts of burden, along the narrow paths which constitute by far the greater number of the roads of the country.

Vehicles appear to be unknown to the Chinese, if we except a sort of wheelbarrow, which is the common conveyance of the people around and in Shanghai; this probably was borrowed in idea from Europeans, and is only used as a public conveyance, and not for goods of any kind. Such being the case, all the great tracks of commercial enterprise in China lie along the rivers and canals. M. Huc says very truly that it is easy to form perfectly opposite ideas of the population of China, according to the route by which you traverse it. If, for example, in the central provinces you travel along the roads, you would be led to believe the country much less populous than it really is. The villages are few and far between, and the waste lands so considerable, that you might at times fancy yourself in the deserts of Tartary. But traverse the same province by the canals or rivers, and the aspect of the country is entirely changed. Often you pass huge cities, containing not less than two or three millions of inhabitants, whilst smaller towns and great villages follow each other in almost uninterrupted succession.

The valley through which the Yang-tse flows in the Empire of China lies chiefly between 26° and 32° degrees of

north latitude, which region, as Sir John Davis remarks, is the favoured climate of tea and silk, and includes some of the finest portions of China. This valley is drained by numerous rivers, which empty themselves into the Yang-tse, and bear on their surface the wealth and commerce of the districts through which they flow. Canals running in every direction also serve the purpose of great commercial arteries, relieving those districts uncommunicated with by rivers. Thus this great river, by its branches and canal communications, is the channel by which an immense amount of produce passes from the most fertile districts of that most fertile country—China. So extensive is the country commanded by the river, that it includes nearly one half of China proper, and that the more important half. This commercial channel also has the great advantage of not being capable of closure by the word of the Chinese autocrat, so long as we have gunboats as superior to those of the Chinese as are the ones we have at present.

This natural outlet of a great part of the indispensable productions of this country was opened, for about six hundred miles, *i. e.*, to Hankow, by the last treaty of Tientsin, and at the present time regular lines of steamers ply between Shanghai, Hankow, and the other settlements on the river, three or four times a week. Numerous lighthouses and beacons have been erected on the banks of the river, to permit of both day and night traffic. Trade has received an immense impulse, and a new era has been opened to China through this step, which has rendered the interior of the kingdom accessible to foreigners. I believe steam navigation to be capable of being carried more than double its present extent, did circumstances permit. The only impediment would be the rapids near I-chang-fou (already nine hundred and fifty miles up the river), and as these are passed by the largest junks, they would be no great or insu-

perable obstacle. There are numerous beds of coal at various points in close proximity to the river, which, though not of first-class quality, could still be made available for steam use.

It is expected that the river will be open to a greater extent shortly, and as the light steamers at present plying upon it could travel considerably further up the river, this step would be of no little importance. It is to be hoped the Imperial Government will see, from the advantages that have accrued to them since the opening to Hankow, that it would be greatly to their interest to have it opened yet further. The mercantile portion of the community—at least that portion which has had transactions with foreigners—has always been in favour of increasing the facilities for travel and commerce with Europeans. But the nobles, mandarins, and literati are, as a rule, greatly opposed to any extension of liberty to the European, and as they hold the chief offices of Government, any advance in this matter meets with great opposition.

The Western interior of China, and the Chinese Empire generally, together with the adjacent country of Thibet, is still a comparative *terra incognita*, although some few daring travellers have risked their lives in exploring parts of these regions. With the new treaty and regíme, travelling is rendered much less hazardous, and hence is getting more general, so that in a comparatively short time the whole of this country may be well known and traversed. At present on account of the many hindrances put in the way of foreigners travelling, as well as from the peculiar temperament of the Chinese, it is a serious undertaking to travel in parts far removed from European stations. Even so late as 1868, M. de Carne, on entering Chinese towns but a moderate distance from Hankow, was often saluted by showers of stones, and it required the greatest prudence to prevent affairs becoming more serious. The opinion of foreigners held by the interior

people is not very flattering, and we were often saluted by their general name for them, " foreign devils," as we passed up the river.

However, we may hope now that Commerce, the precursor of civilisation, has in some measure penetrated the interior of their great empire, the Chinese will no longer remain stationary in their semi-barbaric condition, but, awaking from their torpor, press forward toward the van of civilised nations; only to rest when they, who have all the requisite capabilities, shall have reached the foremost rank.

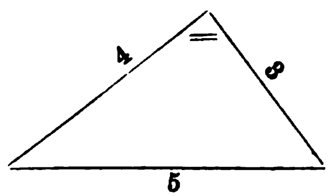
PYTHAGOREAN TRIANGLES.

By W. ALLEN WHITWORTH.

1. Def.—*A Pythagorean Triangle is a right-angled triangle having all its sides commensurable.*

In other words, the ratios of the sides are the ratios of three integers.

A familiar example is the triangle whose sides are 3, 4, 5, right-angled because $3^2 + 4^2 = 5^2$. *Eucl.* I. 47.



But an infinite variety of such triangles can be formed, and they can be constructed so as to conform, as nearly as you please, to any given configuration; *i.e.*, if a right-angled triangle be given whose sides are not commensurable, a Pythagorean triangle can be formed to differ from the given triangle as to the magnitude of its angles by less than any assigned angle, or as to the ratio of any two sides by less than any assigned difference.

2. We shall assume throughout that all the ratios are expressed in their lowest terms, *i.e.*, we shall not regard the triangles whose sides are—

$$6\ ,\ 8\ ,\ 10$$

or

$$9\ ,\ 12\ ,\ 15$$

as being different triangles from the triangle—

$$3\ ,\ 4\ ,\ 5$$

3. Since the three integers representing the sides of

such triangles as we are considering have no common factor, no two of them can have a common factor. For a common factor of two of them would be a common factor of their squares, and therefore of the sum or difference of their squares. But the sum or difference of the squares is the square on the remaining side (*Eucl.* I. 47).

$\therefore$ The factor would be a factor of the third square, and therefore of the third side, which is contrary to hypothesis.

$\therefore$ The three integers are prime to one another.

4. It follows that only one of the three integers can be even; and since all odd squares are of the form $4N + 1$, the relation (*Eucl.* I. 47) cannot be satisfied unless the hypothenuse is odd, and one of the other sides odd and one even. For we can have—

$$(4N + 1) + (4N') = (4N'' + 1),$$

but we could not have—

$$(4N + 1) + (4N' + 1) = (4N''),$$

nor—

$$(4N + 1) + (4N' + 1) = (4N'' + 1).$$

Since the square on the even side is the difference of two odd squares, it must be divisible by 8. Therefore the even side must be divisible by 4.

5. One of the sides containing the right angle of a Pythagorean triangle must be divisible by 3. For every square number is of the form $9\,N$ or $9\,N + 1$; therefore, to satisfy *Eucl.* I. 47, we must have—

$$(9N) + (9N' + 1) = (9N'' + 1),$$

since neither

$$(9N + 1) + (9N' + 1) = (9N'')$$

nor

$$(9N + 1) + (9N' + 1) = (9N'' + 1)$$

is possible.

6. One of the sides must be divisible by 5. For every

square number is of one of the forms—$5N$, $5N+1$, $5N-1$; therefore we cannot have—

$$(5N+1)^2 + (5N+1)^2 = \text{square}.$$

We must have, to satisfy *Eucl.* I. 47, either

$$(5N+1)^2 + (5N'-1)^2 = (5N'')^2,$$

or

$$(5N)^2 + (5N'-1)^2 = (5N''+1)^2.$$

That is, one of the three sides must be a multiple of 5.

7. Thus it appears that not only is 3, 4, 5 the simplest example of a Pythagorean triangle, but all other Pythagorean triangles have the numbers 3, 4, 5 as factors of some of their sides.

Let us notice, however, that 3 and 4 are never factors of the hypothenuse; 5 can be a factor of *any* of the three sides.

An example in which the first side is divisible by 3, second by 4, third by 5, is given by the triangle—

$$33 : 56 : 65$$

An example in which 3 and 4 are factors of the second side, and 5 of the hypothenuse, is—

$$7 : 24 : 25.$$

Examples in which 5 is a factor of one of the smaller sides are—

$$5 : 12 : 13$$
$$9 : 40 : 41$$

An example in which the three factors, 3, 4, 5, all occur in one side is—

$$11 : 60 : 61$$

Or, again—

$$119 : 120 : 169$$

8. Let x be the odd side, y the even side, and z the hypothenuse of any Pythagorean triangle. Then y, $z-x$, and $z+x$ are all even; and we have *Eucl.* I. 47—

$$y^2 = z^2 - x^2$$

Or—

$$\left(\frac{y}{2}\right)^2 = \left(\frac{z-x}{2}\right)\left(\frac{z+x}{2}\right)$$

Now, the integers $\frac{z-x}{2}$ and $\frac{z+x}{2}$ are one even and one odd, since their sum z is odd. They are also prime to one another; for if they had a common factor, it would be common to their sum and difference, z and x, which is contrary to hypothesis (Art. 2). Therefore, their product being a square, each of them must be itself a square. Therefore, we may write—

$$z + x = 2\alpha^2$$
$$z - x = 2\beta^2$$

whence we have—

$$x = \alpha^2 - \beta^2 \quad y = 2\alpha\beta \quad z = \alpha^2 + \beta^2.$$

Hence the hypothenuse is always the sum of an odd and an even square; and if any given number be the sum of an odd and even square prime to one another, at least one Pythagorean triangle can be found having the given number as hypothenuse.

E. g., we have the Pythagorean triangles—

3	:	4	:	5	where $5 = 1^2 + 2^2$
5	:	12	:	13	where $13 = 2^2 + 3^2$
15	:	8	:	17	where $17 = 1^2 + 4^2$

etc.

9. Fermat has proved that every prime number of the form $4N + 1$ is the sum of two squares. Therefore—

Every prime number of the form $4N + 1$ *is the hypothenuse of a Pythagorean triangle.*

10. Also, since every number of the form $4N - 1$ is the difference of two squares $[N^2 - (N - 1)^2]$, it must be the odd side of the Pythagorean triangle whose even side is $2N^2 - 2N$, and hypothenuse $2N^2 - 2N + 1$.

11. We may further remark that, if a number can be expressed in more than one way as the sum of an odd and even square prime to one another, it will be the hypothenuse of more than one Pythagorean triangle.

E. g.,—

$$65 = 1^2 + 8^2$$

Also,—

$$= 4^2 + 7^2$$

Therefore, we have the two Pythagorean triangles—

$$63 \;:\; 16 \;:\; 65$$

and—

$$33 \;:\; 56 \;:\; 65$$

12. *A prime number cannot be expressed as the sum of two squares in more than one way.*

If possible, let P be a prime number, and—

$$P = h^2 + k^2$$
$$P = p^2 + q^2$$

Multiply the first equation by $p^2 - q^2$, and the second by $h^2 - k^2$, and add, then—

$$(p^2 - q^2 + h^2 - k^2)\,P = 2\,(h^2 p^2 - q^2 k^2)$$
$$= 2\,(hp - qk)\,(hp + qk) \quad . \; . \; . \; (1)$$

Now,— $$2hp < h^2 + p^2$$
$$2qk < q^2 + k^2$$

$\therefore$ $$2\,(hp + qk) < h^2 + k^2 + p^2 + q^2$$

$\therefore$ $$< 2P$$

$\therefore$ $$hp + qk < P \qquad \text{A fortiori } hp - qk < P$$

$\therefore$ Every factor in the second member of (1) is less than P, which is a prime factor of the first member, which is impossible. Q. E. D.

Hence a prime number is the hypothenuse of only one Pythagorean triangle. And—

Every prime number of the form 4N + 1 is the hypothenuse of one, and only one, Pythagorean triangle.

Thus we find the triangles—

3	4	5
5	12	13
15	8	17
21	20	29
35	12	37
9	40	41
	etc.	

13. *The square cube, and all other powers of a prime hypothenuse, are the hypothenuses of Pythagorean triangles.*

For if—

$$z = \alpha^2 + \beta^2$$

then—

$$z^2 = (\alpha^2 - \beta^2)^2 + (2\alpha\beta)^2$$

$$z^3 = (\alpha^3 - 3\alpha\beta^2)^2 + (3\alpha^2\beta - \beta^3)^2$$

$$z^4 = (\alpha^4 - 6\alpha^2\beta^2 + \beta^4)^2 + (4\alpha^3\beta + 4\alpha\beta^3)^2$$

$$z^5 = (\alpha^5 - 10\alpha^3\beta^2 + 5\alpha\beta^4)^2 + (5\alpha^4\beta - 10\alpha^2\beta^3 + \beta^5)^2$$

and so on;

and generally—

$$z^n = \left(\alpha^n - \frac{n(n-1)}{1\,.\,2}\alpha^{n-2}\beta^2 + \frac{n(n-1)(n-2)(n-3)}{1\,.\,2\,.\,3\,.\,4}\alpha^{n-4}\beta^4 - \&c.\right)^2 + \left(\frac{n}{1}\alpha^{n-1}\beta - \frac{n(n-1)(n-2)}{1\,.\,2\,.\,3}\alpha^{n-3}\beta^3 + \&c.\right)^2$$

Hence any power of z is resolvable into the sum of two squares. And these squares are prime to one another, for if they had a common factor z must divide them. But if z *i.e.* $(\alpha^2 + \beta^2)$ divided the first of them we must have—

$$0 = 1 + \frac{n(n-1)}{1\,.\,2} + \frac{n(n-1)(n-2)(n-3)}{1\,.\,2\,.\,3\,.\,4} + \&c.$$

Or the sum of a series of positive integers = zero, which is impossible.

Therefore, any power of a prime hypothenuse is the hypothenuse of a Pythagorean triangle.

Thus, since 5 is an hypothenuse, we have the Pythagorean triangles.

7	:	24	:	25
117	:	44	:	125
527	:	336	:	625
237	:	2916	:	3125

14. We may express the last result as follows :—

If a prime number p be the hypothenuse of a right-angled triangle, whose sides are expressed by the integers q and r, a right-angled triangle can be formed on the hypothenuse p^n (where n is any integer), having its sides expressed by integers, viz. :—

$$\frac{(q + r\sqrt{-1})^n + (q - r\sqrt{-1})^n}{2}$$

and—

$$\frac{(q + r\sqrt{-1})^n - (q - r\sqrt{-1})^n}{2\sqrt{-1}}$$

15. *The product of two prime hypothenuses will be itself the hypothenuse of two Pythagorean triangles.*

For if $z\ z'$ be two prime hypothenuses, we may write—

$$z = \alpha^2 + \beta^2 \qquad z' = \alpha'^2 + \beta'^2$$

$$\therefore \qquad zz' = (\alpha\alpha' - \beta\beta')^2 + (\alpha\beta' + \alpha'\beta)^2$$

Or—

$$= (\alpha\alpha' + \beta\beta')^2 + (\alpha\beta' - \alpha'\beta)^2$$

Thus zz' is expressed in two ways as the sum of two squares, and the two squares are prime to one another. For if they had a common factor, they must have a common square factor, and it must needs be a factor of zz'. But as z and z' are prime numbers, $z\ z'$ has no square factor.

$\therefore$ zz' is the hypothenuse of two Pythagorean triangles.

Thus 5 and 17 being prime hypothenuses, their product 85 is the hypothenuse of the two triangles—

13	:	84	:	85
77	:	36	:	85

16. *The product of n prime hypothenuses, all different, will be itself the hypothenuse of 2^{n-1} Pythagorean triangles.*

Let $(\alpha_1^2 + \beta_1^2)$, $(\alpha_2^2 + \beta_2^2)$, $(\alpha_3^2 + \beta_3^2)$, . $(\alpha_n + \beta_n)$ be the n prime hypothenuses;
and let—

$$P + Q\sqrt{-1} = (\alpha_1 + \beta_1\sqrt{-1})(\alpha_2 + \beta_2\sqrt{-1})$$
$$(\alpha_3 + \beta_3\sqrt{-1}) \dots (\alpha_n + \beta_n\sqrt{-1}) \dots (1)$$

then—

$$P - Q\sqrt{-1} = (\alpha_1 - \beta_1\sqrt{-1})(\alpha_2 - \beta_2\sqrt{-1})$$
$$(\alpha_3 - \beta_3\sqrt{-1}) \dots (\alpha_n - \beta_n\sqrt{-1}) \dots (2)$$

Therefore—

$$P^2 + Q^2 = (\alpha_1^2 + \beta_1^2)(\alpha_2^2 + \beta_2^2)(\alpha_3^2 + \beta_3^2) \dots (\alpha_n^2 + \beta_n^2) \dots (3)$$

Hence the product of the given hypothenuses is equal to the sum of the squares P^2 and Q^2, and these are prime to one another, for if P and Q had a common factor, each member of (1) would have a rational factor; but the second member has no such factor, since α is prime to β. Hence the product of the given hypothenuses is the hypothenuse of the triangle—

$$P^2 - Q^2 \quad : \quad 2\,PQ \quad : \quad P^2 + Q^2$$

Now let —

$P_1 + Q_1\sqrt{-1}$ = what the second member of (1) becomes when the signs of any *but not all* of the β's are changed. Then, as before, the product of the given hypothenuses is the hypothenuse of the triangle—

$$P_1^2 - Q_1^2 \quad : \quad 2\,P_1 Q_1 \quad : \quad P_1^2 + Q_1^2$$

And by changing the signs of different β's 2^{n-1} variations of P and Q will ensue. Therefore the product of n given hypothenuses is the hypothenuse of 2^{n-1} different Pythagorean triangles.

16. For example, $1105 = 5 \times 13 \times 17$ is the product of three prime hypothenuses. Hence we have 2^{3-1} or 4 Pythagorean triangles with 1105 as hypothenuse, viz.:—

47	:	1104	:	1105
817	:	744	:	1105
943	:	576	:	1105
1073	:	264	:	1105

Similarly, 2465, which is nearly the highest hypothenuse in the accompanying table, being the product of three prime factors ($5 \times 17 \times 29$), is the hypothenuse of four triangles, viz.:—

897	:	2296	:	2465
1407	:	2024	:	2465
1953	:	1504	:	2465
2337	:	784	:	2465

Again,—$32045 = 5 \times 13 \times 17 \times 29$ is the product of four prime hypothenuses. Hence we have 2^{4-1}, or eight Pythagorean triangles, with 32045 as hypothenuse, viz.:—

2277	:	31264	:	32045
8283	:	30956	:	32045
16853	:	27004	:	32045
21093	:	24124	:	32045
23067	:	22244	:	32045
27813	:	15916	:	32045
31323	:	6764	:	32045
32037	:	716	:	32045

17. *The product of m prime hypothenuses, of which n only are different, will be itself the hypothenuse of* 2^{n-1} *Pythagorean triangles.*

For the repetitions of any hypothenuse $\alpha^2 + \beta^2$ will not cause any available additional variations in equation (1), since, in giving the signs to the β's, all the factors, $\alpha + \beta\sqrt{-1}$, $\alpha + \beta\sqrt{-1}$, which are alike, must have the same sign prefixed to β. For, if $\alpha + \beta\sqrt{-1}$ and $\alpha - \beta\sqrt{-1}$ both occurred in (1), $\alpha^2 + \beta^2$ would be a common factor of P and Q, and no Pythagorean triangle would result.

18. For example, $325 = 5 \times 5 \times 13$ being the product of three prime hypothenuses, of which only two are different, will be the hypothenuse of only two triangles, viz.:—

253 : 204 : 325
323 : 36 : 325

Again, $1625 = 5 \times 5 \times 5 \times 13$ being the product of four prime hypothenuses, of which only two are different, will be the hypothenuse of only two triangles, viz.:—

57 : 1624 : 1625
1113 : 1184 : 1625

19. The accompanying table gives all the Pythagorean triangles, 395 in number, whose hypothenuses are less than 2,500.

The hypothenuses, for distinction, are printed in thick type, and are seen to be (in accordance with what we have shown)—

I. The prime numbers of the form $4n + 1$, each occurring once, viz.:—5, 13, 17, 29, 37, 41 ...... 2477.

II. Their squares, cubes, and higher powers, each occurring once, viz.:—25, 125, 169, 225, 289, &c.

III. The products of two of them, or powers of two of them, each occurring twice, viz.:—65, 65; 85, 85; &c.

IV. The products of more than two, occurring oftener, in accordance with the rule first investigated.

Problems.

20. *To find a Pythagorean triangle approximately a "half-square."*

Put— $$\frac{\alpha^2 - \beta^2}{\alpha^2 + \beta^2} = \frac{1}{\sqrt{2}} \text{ nearly.}$$

Then— $$\frac{\alpha^2}{\beta^2} = \frac{\sqrt{2} + 1}{\sqrt{2} + 1} = 3 - 2\sqrt{2}$$

$$\frac{\alpha}{\beta} = \sqrt{2} + 1$$

For $\sqrt{2}$ take any approximation as close as you please:

$$\frac{7}{5} \text{ or } \frac{99}{70}$$

Then—

$$\frac{\alpha}{\beta} = \frac{12}{5} \text{ or } \frac{169}{70}$$

which gives the Pythagorean triangles—

$$119 \; : \; 120 \; : \; 169$$

and—

$$23661 \; : \; 23660 \; : \; 33461$$

21. *To find a Pythagorean triangle approximately similar to half an equilateral triangle.*

Put—

$$\frac{\alpha^2 - \beta^2}{\alpha^2 + \beta^2} = \frac{1}{2}$$

Then—

$$\frac{\alpha^2}{\beta^2} = 3$$

$$\frac{\alpha}{\beta} = \sqrt{3} = \frac{7}{4} \text{ or } \frac{26}{15}$$

which give the Pythagorean triangles—

$$33 \; : \; 56 \; : \; 65$$

and—

$$451 \; : \; 780 \; : \; 901$$

22. *To find a Pythagorean triangle having its shorter sides in the ratio* 2 : 3.

Put—

$$\frac{2\,\alpha\,\beta}{\alpha^2 - \beta^2} = \frac{2}{3}$$

$$\alpha^2 - \beta^2 = 3\,\alpha\,\beta$$

$$\alpha^2 - 3\,\alpha\,\beta + \frac{9}{4}\beta^2 = \frac{13}{4}\beta^2$$

$$\frac{\alpha}{\beta} = \frac{3 + \sqrt{13}}{2}$$

Take $\frac{11}{3}$ or $\frac{65}{18}$ as an approximation to $\sqrt{13}$

$$\frac{\alpha}{\beta} = \frac{3}{2} + \frac{11}{6} \text{ or } \frac{3}{2} + \frac{65}{36}$$
$$= \frac{10}{3} \text{ or } \frac{119}{36}$$

Whence we have the triangles—

$$91 \quad : \quad 60 \quad : \quad 109$$

and—

$$12865 \quad : \quad 8568 \quad : \quad 15457$$

The Trigonometry of Pythagorean Triangles.

23. Let $\theta_1\ \theta_2\ \theta_3 \ldots\ldots \theta_n$ be acute angles of n Pythagorean triangles, whose hypothenuses are $z_1\ z_2\ z_3 \ldots\ldots z_n$,

$$\left.\begin{array}{llll} \text{Then} & z_1\ Cos\ \theta_1 & z_2\ Cos\ \theta_2 & \ldots\ldots \\ \text{and} & z_1\ Sin\ \theta_1 & z_2\ Sin\ \theta_2 & \ldots\ldots \end{array}\right\} \text{are all integers.}$$

Therefore—

$$\left.\begin{array}{c} z_1\ (Cos\ \theta_1 + \sqrt{-1}\ Sin\ \theta_1) \\ z_2\ (Cos\ \theta_2 + \sqrt{-1}\ Sin\ \theta_2) \\ z_3\ (Cos\ \theta_3 + \sqrt{-1}\ Sin\ \theta_3) \\ \&c. \end{array}\right\} \text{ are all integral.}$$

And therefore their product, which is—

$$z_1\ z_2\ z_3 \ldots\ z_n \left\{ Cos\ (\theta_1 + \theta_2 + \ldots\ \theta_n - r\,\pi) \right.$$
$$\left. + \sqrt{-1}\ Sin\ (\theta_1 + \theta_2 + \ldots + \theta_n - r\,\pi) \right\}$$

is integral.

Therefore, $z_1\ z_2 \ldots\ z_n$ is the hypothenuse of a Pythagorean triangle, having the acute angle $\theta_1 + \theta_2 + \ldots + \theta_n - r\,\pi$, and equally $z_1\ z_2 \ldots\ z_n$ is the hypothenuse of a Pythagorean triangle having any acute angle of the form $\theta_1 \pm \theta_2 \pm \theta_3 \ldots \pm \theta_n - r\pi$.

24. By the help of tables, we find that the smaller acute angles of the Pythagorean triangles whose hypothenuses are 5 and 13 are—

$36° \; 52'$

$22° \; 37'$

Their difference is—

$14° \; 15'$

and their sum—

$59° \; 29'$

of which the complement is—

$30° \; 31'$

Hence $14° \; 15'$ and $30° \; 31'$ are the smaller acute angles of the triangles of hypothenuse 65, viz.:—

63 : 16 : 65

and— 56 : 33 : 65

Again, since the angle of hypothenuse 5 is—

$36° \; 52'$

its double is—

$73° \; 44'$

of which the complement is—

$16° \; 16'$

which is, therefore, the smaller acute angle of hypothenuse 25, *i. e.*, of the triangle—

7 : 24 : 25.

Thus if we know the angles of those Pythagorean triangles whose hypothenuses are prime numbers, we can find the angles of all other Pythagorean triangles by simple addition and subtraction.

THE JANAL DODECAHEDRA.

By THOMAS P. KIRKMAN, M.A., F.R.S.

For the honour of that imperial solid, the regular 12-edron, I design to place on record a complete account of all the 12-edra. For one communication on a subject so abstruse, which seems hardly to have touched the fancy of any other investigator, a description of the janal 12-edra will suffice. The non-janals are, beyond comparison, the more numerous; but by far the most difficult part of the general problem is the determination of the janal polyedra, without which it is impossible to describe or enumerate the rest.

A polyedron is *janal*, when it has one or more diameters, about whose extremities two opposite eyes read configurations which are either identical, or one the reflected or inverted image of the other.

A polyedron is *zoned*, when a line of bisection can be drawn on it, such that its two halves reflect each other, as an object its image when touching a mirror. The bisecting line, or *zone*, passes through *zoned faces* and *summits*; the edges in the zone are *zonal*; those cut by it, *epizonal edges*. A polar edge is zonal in one and epizonal in another zone. A face or summit, having the trace of one zone only, is a *monozone face or summit*.

A diameter which is the intersection of two or more zones is a *zoned axis*, whose terminations, face, summit, or edge, are *zoned poles*. In a *janal axis*, the two like poles are *janal zoned poles*. The zoned axis will be two-zoned or m-zoned, as 2 or m zones intersect in it. When m is odd, the m zones have all one configuration, *i.e.*, the halves made by bisection in any zone containing the m-zoned axis will be

identical polyedra; when m is even, the zones have two alternately placed configurations, and two different pairs of halves can be obtained by such bisection, except when the solid is a $2n$-*zoned homozone* polyedron, in which case the same pair of like halves is obtained by section in every zone about the homozone janal axis.

A *principal zoned axis* has the greatest number of zones. If there is but one principal zoned janal axis, the solid is a *zoned monarchaxine* polyedron; if there are three or six of them, it is a *triarchaxine* or *hexarchaxine*. There are never four principal *janal* axes, yet the zoned tetrarchaxine polyedron is a janal solid, because it has zoned janal secondary axes. The number of principal axes can only be one, three, four, or six. There are janal zoned secondary and tertiary axes in the zoned triarchaxines and hexarchaxines, but only zoned secondaries in the zoned tetrarchaxines and monarchaxines, the latter of which has janal secondaries only when it is $(2m+4)$-zoned. It will suffice to describe more closely these solids as we construct them among the janal 12-edra.

A *zoneless r-ple axis* is a diameter, about whose extremities, or *zoneless poles*, are read zoneless configurations r times repeated, in the revolution of the solid about the axis. When the r-ple axis is janal, the opposite configurations read are the same, or one the inverted image of the other.

A zoneless $2r$-ple monarchaxine $(r > 1)$ has one principal janal $2r$-ple axis, at right angles to the plane of $2r$ secondary janal 2-ple axes, r of one configuration alternately placed with r of another; showing $2r$ poles alternating with $2r$ different poles.

A zoneless $(2r+1)$-ple monarchaxine has $2r+1$ similar non-janal secondary 2-ple axes, showing $2r+1$ poles alternating with $(2r+1)$ different poles.

There are also, but not among the 12-edra, triarchaxine, tetrarchaxine, and hexarchaxine zoneless polyedra.

An *r-ple monaxine janal* polyedron has but one zoneless axis, whose opposite polar configurations are one the reflected image of the other.

A *monarchaxine homozone* polyedron has one janal $(3 + r)$-zoned axis at right angles to the plane of $3 + r$ janal 2-ple axes, whose $6 + 2r$ zoneless poles are all alike.

An *r-ple monaxine monozone* polyedron has one r-ple janal zoneless axis, at right angles to a zone. When r is even, but not when r is odd, opposite eyes read about any diameter of the vertical zone, configurations of which one is the inverted image of the other; and at the poles of the zoneless axis, configurations of which one is the reflected image of the other.

A *zoned triaxine* polyedron has three 2-zoned janal axes, of three polar configurations.

A *zoneless triaxine* polyedron has three 2-ple janal axes, of three different polar configurations.

A *homozone triaxine polyedron* has one 2-zoned homozone janal axis, and two 2-ple zoneless axes, having the same zoneless polar configuration at their four poles.

A *janal anaxine polyedron* has neither zone nor pole, but all its diameters are janal, so that every feature is diametrically opposite to its reflected image, as read by opposite eyes. Every face, summit, or edge of it is *janal anaxine.*

It is unnecessary here to give an account of non-janal polyedra. All this will follow; further details, with demonstrations, may be found in the fragment No. XXV of the *Philosophical Transactions* of 1862.

In speaking above of diameters, angles, and reflexions, we conceive the polyedron to have all possible symmetry. But, for our enumeration and description, no distortion by alteration of length of sides, or of their angles, can make any

difference. Our results are neither obtained nor obtainable by study of the pictured solids.

All non-polar and zoneless faces, summits or edges, which are *janal anaxine* on the 12-edra are enumerated in the following tables. Such features are found only in the following polyedra :—

1. Zoned Hexarchaxines;
2. Zoned Triarchaxines;
3. $2m$-zoned Monarchaxines;
4. $(2m + 3)$-zoned Monarchaxine Homozones;
5. $2m$-ple monaxine monozones;
6. $(2m + 3)$-ple monaxine-janals;
7. Zoned triaxines;
8. Janal anaxine polyedra.

The janal polyedra, not here included, have no janal feature besides the poles of their janal axes, which poles are all of them that will find place in our present tables. But we shall enumerate and often construct those excluded janal solids. Non-janal features are enumerated in tables formed after the janal tables, and not here given.

JANAL 8-ACRAL 12-EDRA.

TABLE A.—THE JANAL SOLIDS.

1. One Zoned Tetrarchaxine.
2. One 6-zoned Monarchaxine.
3. One 3-zoned Monarchaxine homozone.
4. One homozone triaxine.

TABLE B.—JANAL POLES.

Janal zoned polar summits: 6-zoned, $(6) = 1$;
2-zoned, $(4) = 1$;
Homozone polar summit: 3-zoned, $(3) = 1$;

Janal zoned polar edge : (33) = 1 ;
Homozone polar edges : (33) = 2 ;
Janal zoneless polar edges : (33) = 2.

TABLE C.—JANAL MONOZONE FEATURES.

Janal monozone faces : (3) = 3 ;
Janal monozone summit : (5) = 1 ;
Janal zonal edges : (33) = 2 ;
Janal epizonal edge : (33) = 1.

(3), (5), (33) stand for the number indicated of triangles, five-aces (*i.e.*, summits of five angles), or intersections of two triangles.

Literal Constructions.—We construct the faces of the solid by naming their summits, and writing them in their order round the faces. Summits denoted by $A_1A_2 \ldots a_1a_2$ . . capital or small, have the same configuration ; that is, they are either identical or one the reflected image of another. Different letters mark different configurations. An *m*-ace will occur *m* times in the construction, once in each face about it. Every edge occurs twice as a consecutive duad. All consecutive duads are, but non-consecutive duads are not, edges. No non-consecutive duad occurs twice.

The first in Table $\bar{A}$ is :—

$$A_1B_2B_3,\ A_1B_3B_4,\ A_1B_4B_2;\ A_2B_3B_4,\ A_2B_4B_1,\ A_2B_1B_3;\ A_3B_4B_1,$$
$$A_3B_1B_2,\ A_3B_2B_4;\ A_4B_1B_2,\ A_4B_2B_3,\ A_4B_3B_1.$$

A_1 is a polar zoned triace, the common vertex of three monozone triangles ; for if they were 3-zoned they would not have two summits, but would be of the form $A_1A_2A_3$. The three-zoned hexace B_1 is the opposite pole to A_1 of the principal axis A_1B_1, and there are four such axes. B_2B_3 and B_1B_4 are two opposite zoned polar edges of a secondary homozone janal axis, and there are three such axes. There is but one

face, which being non-janal monozone is not in Table C. On this face, any one of the twelve, the solid can be drawn in projection, by lines joining five points within the face.

The second in Table A is two hexagonal pyramids joined base to base. Three secondary zoned axes end in polar 2-zoned 4-aces, and three others in polar edges. There is but one face, a monozone triangle, and only two edges, a polar and a zonal.

The third in Table A is :—

AB_1B_2	ab_1b_2	$B_1b_2b_3$	$b_1B_2B_3$
AB_2B_3	ab_2b_3	$B_2b_3b_1$	$b_2B_3B_1$
AB_3B_1	ab_3b_1	$B_3b_1b_2$	$b_3B_1B_2$

We see that A and a are polar triaces of a three-zoned janal axis. $b_3B_1B_2$ and AB_1B_2 are monozone triangles on the same epizonal B_1B_2, and b_3B_1 in the former, not being epizonal, cannot be zoned polar; it is, therefore, zoneless polar in the like triangles $b_3B_1B_2$ and $b_3B_1b_2$, where the configuration of B_2 with A and that of b_2 with a are repeating about the pole, not reflected. There are six zoneless poles, b_3B_1, &c., in three janal zoneless axes.

There are only two faces. There is one zonal edge, AB_1, joining a zoned pentace to a polar zoned triace.

The fourth in Table A is :—

$$A_1A_2B_1,\ A_1A_2B_3,\ A_2B_1B_2,\ A_3B_1B_2,\ A_4B_3B_2,\ A_1B_4B_1,$$
$$A_3A_4B_2,\ A_3A_4B_4,\ A_2B_3B_2,\ A_3B_1B_4,\ A_4B_3B_4,\ A_1B_4B_3.$$

The two homozone polar edges are A_1A_2, A_3A_4, each the base of two like monozone triangles. As the four successive edges of the zoned 4-ace A_1 (read contiguous in the first, sixth, twelfth, and second faces), A_1A_2, A_1B_1, A_1B_4, A_1B_3, are not all alike, it is monozone, and has two zonal edges, the polar A_1A_2, and A_1B_4; A_1B_1 being zoneless. Hence the triangle $A_1B_4B_1$ is not zoned, the edges meeting in A_1 not

being like; therefore, B_4B_1, the base of the triangles $B_1B_4A_1$ and $B_1B_4A_2$, not being zoned, is a zoneless polar edge, having like configurations, not reflected but repeating, on either hand. And there are four of these zoneless poles, B_1B_4, etc. in two axes. Neither the zoned face $A_1A_2B_1$, nor the zoneless face $A_1B_4B_1$, is in our janal tables.

JANAL 10-ACRAL 12-EDRA.

TABLE A.—THE JANAL SOLIDS.

1. One 5-zoned Monarchaxine homozone;
2. One 4-zoned Monarchaxine;
3. Six 2-ple monaxine monozones;
4. Three janal anaxine solids;
5. One monozone triaxine;
6. One zoneless triaxine;
7. One 2-ple janal monaxine.

TABLE B.—JANAL POLES.

Zoned polar faces: 5-zoned, (5) = 1; 2-zoned, (4) = 1:
Zoned polar summits: 4-zoned, (4) = 1; 2-zoned, (6) = 1:
Zoneless polar summits: 2-ple, (6) = 1, (4) = 6:
Zoned polar edges: (44) = 1:
Zoneless polar edges: (44) = 5, (33) = 6.

TABLE C.—JANAL MONOZONE FEATURES.

Monozone faces	(5) = 2,	(3) = 10:		
Monozone summits	(6) = 3,	(5) = 1,	(4) = 5,	(3) = 8:
Zonal edges	(44) = 3,	(33) = 8:		
Epizonal edges	(35) = 3,	(34) = 1,	(33) = 3.	

TABLE D.—JANAL ANAXINE FEATURES.

Janal anaxine edges; (35) = 4, (44) = 3, (34) = 29, (33) = 17.
Janal anaxine faces; (4) = 10, (3) = 21.
Janal anaxine summits; (5) = 7, (4) = 8, (3) = 9.

No. 1 in Table A is :—

$A_1A_2A_3A_4A_5$, $A_1a_3a_4$, $A_2a_4a_5$, $A_3a_5a_1$ $A_4a_1a_2$, $A_5a_2a_3$,
$a_1a_2a_3a_4a_5$, $a_1A_3A_4$, $a_2A_4A_5$, $a_3A_5A_1$, $a_4A_1A_2$, $a_5A_2A_3$.

The only summit is the zoned 4-ace of a 5-zoned pentagon. The epizonal edge, a_3a_4, being in a pentagon, is different from A_1a_3, joining summits in two pentagons, and $A_1a_3a_4$ is a monozone triangle, in which, as well as in $A_1a_3A_5$, the edge A_1a_3 is a zoneless edge ; it must therefore be zoned polar, about which the summits a_4 and A_5 repeat, not reflect each other. There are ten of these polar edges in five janal axes.

No. 2, in Table A, is obtained by crowning the opposite 4-zoned face of a cube with a 4-zoned 4-ace, the (4) in Table B.

The six, No. 3 are :—

(a) $A_1C_1c_2$, $A_1D_2C_2c_1d_1$, $A_1C_1D_2$, $C_1C_2D_2$, $A_2C_2D_1$, $C_2C_1D_1$,
$A_2C_2e_1$, $A_2D_1C_1c_2d_2$, $A_2c_1d_2$, $c_1c_2d_2$, $A_1c_2d_1$, $c_1c_2d_1$.

(b) $A_1D_1B_1$, A_1B_1C, $A_1CB_2D_2$, $A_1D_2b_1c$, A_1cb_2, $A_1b_2D_1$,
$A_2D_2b_1$, A_2b_1c, $A_2cb_2D_1$, $A_2D_1B_1C$, A_2CB_2, $A_2B_2D_2$.

(c) $A_1D_1C_2C_1$, $A_1C_1D_2$, $A_1D_2d_1$, $A_1d_1c_2$, $A_1c_2c_1d_2$, $A_1D_1d_2$,
$A_2d_1c_2c_1$, $A_2c_1d_2$, $A_2d_2D_1$, $A_2D_1C_2$, $A_2C_2C_1D_2$, $A_2D_2d_1$.

(d) $A_1c_1b_2B_1C_2$, $A_1C_2C_1$, $A_1C_1B_2$, $A_1B_2b_1$, $A_1b_1c_2$, $A_1c_2c_1$,
$A_2C_1B_2b_1c_2$, $A_2c_2c_1$, $A_2c_1b_2$, $A_2b_2B_1$, $A_2B_1C_2$, $A_2C_1C_2$.

(e) $A_2d_1D_2$, A_2D_2C, $A_2CD_1B_2$, $A_2B_2d_2c$, A_2cd_1, $B_2D_1d_2$,
$A_1D_1d_2$, A_1d_2c, $A_1cd_1B_1$, $A_1B_1D_2C$, A_1CD_1, $B_1D_2d_1$.

(f) $B_1c_1C_2$, $D_1c_1C_2$, $A_1B_1C_2C_1$, $A_1C_1D_2$, $A_1D_2c_2$, $A_1B_1c_1c_2$,
$B_2C_1c_2$, $D_2C_1c_2$, $A_2B_2c_2c_1$, $A_2c_1D_1$, $A_2D_1C_2$, $A_2B_2C_1C_2$.

The revolution of the 2-ple monaxine monozone about its zoneless axis brings twice into view every zoned, and four times into view every zoneless, feature ; this is evident

from our definitions of zone and 2-ple axis; but the zoneless poles themselves are not so repeated. If the pole is a summit C, the opposite pole will be c, and there will be no third C; but if C be a zoneless summit, there will be four of that name. So any zoneless face will be four times written in like letters. Any 2m-gonal face that is only twice written with like letters, is sure to be either zoned or the zoneless pole. No zoneless non-polar edge will be read fewer than eight times; if one not zoned appears only four times, it will be the zoneless polar edge.

In (a) C_1c_2, which is written with those two letters only four times, cannot be the zoneless polar edge; for that pole must be the intersection of like faces; wherefore C_1c_2 is epizonal, carrying a monozone pentagon and triangle; and C_1C_2 is the zoneless pole. There are two zoneless triangles $C_1C_2D_2$, $A_1C_1D_2$, one zoned 4-ace A_1, and one zoneless pentace C_1.

In (b) There is evidently no zoned face. The names A, D, and C occur each in pairs only. Two must be zoned summits, and the other a zoneless pole. We see that A_1D_1 is one zonal, the base of the triangles $A_1D_1B_1$ and $A_1D_1b_1$ which reflect each other, and A_1D_2 is another zonal, on which $A_1D_2B_2C$ and $A_1D_2b_1c$ reflect each other. Hence C is the polar 4-ace, A_1 is a zoned hexace, D_1 a zoned 4-ace, and there are two triangles and one 4-gon which are zoneless or janal anaxine.

In (c) D_1d_2 is epizonal in two monozone triangles, and C_1C_2 is the zoneless polar edge, the intersection of two like janal anaxine 4-gons.

In (d) B_2b_1 is epizonal; and C_1C_2, the polar edge, is common side of two janal anaxine triangles.

In (e) C is the zoneless polar four-ace; D_1d_2 is epizonal; and A_2B_2 is zonal.

In (f) A_1D_2 is zonal; c_1C_2 is epizonal; and C_1C_2 is zoned polar edge.

Any of these solids can be projected upon any one of its faces.

The three janal anaxine solids of A, Table A, are :—

(a) ABCD, ABd, BCae, CaD, DbE, DEA,
abcd, abD, bcAE, cAd, dBe, dea.

(b) ABCD, AED, BeC, CeaD, ABe, EDa,
abcd, aed, bEc, cEAd, abE, edA.

(c) ACDE, ABd, BCA, CDe, DbcE, EdA,
acde, abD, bca, cdE, dBCe, eDa.

None of these can be symmetrical, because the two 4-gons have not like summits, and no two solids can be the same, because they have not the same pair of 4-gons. The circuits are, 5345, 5343 ; 5345, 5433 ; 5444, 5443.

The homozone triaxine, 5, of Table A, is :—

AB_1C_2, AC_2B_2, $AB_2c_2B_3$, AB_3C_1, AC_1B_4, $AB_4c_1B_1$,
aB_1c_1, ac_2B_2, $aB_1C_2B_2$, aB_3c_2, ac_1B_4, $aB_4C_1B_3$.

There is no polar edge; the two-zoned 6-ace A has in one zone the zonals AC_1 and AC_2, and in the other two 4-gons, in all which the 4-aces B reflect each other; and these B are the four like poles of the two zoneless axes, each having about it the repetition ACac on its four edges.

The zoneless triaxine, No. 6, is :—

$AD_1b_2B_1$, AB_1d_2, Ad_2D_2, $AD_2b_1B_2$, AB_2d_1, Ad_1D_1,
$ad_1B_2b_1$, ab_1D_2, aD_2d_2, $ad_2B_1b_2$, ab_2D_1, aD_1d_1.

One 2-ple janal axis carries the 2-ple hexaces A and a; another the polar edges, b_1B_2, B_1b_2, the intersections of like 4-gons ; and another the polar edges, d_1D_1 and d_2D_2.

The 2-ple monaxine janal, No. 7, is :—

AB_1C_1, $AC_1c_1B_2$, AB_2C_2, $AC_2c_2B_1$, $B_1C_1c_2$, $B_2C_2c_1$,
ab_1c_1, $ac_1C_2b_2$, ab_2c_2, $ac_2C_1b_1$, $b_1c_1C_1$, $b_2c_2C_2$.

The two polar summits are A and a, two-ple 4-aces. There is no other pole, for it would be a feature in symmetry either about A and a, or about neither; but there is no such feature. C and B are asymmetric 5-ace and tri-ace.

JANAL 12-ACRAL 12-EDRA.

TABLE A.—THE JANAL SOLIDS.

1. Two zoned triaxines;
2. Eighteen 2-ple monaxine monozones;
3. Twenty-four janal anaxine solids;
4. Four homozone triaxines;
5. Five 2-ple janal monaxines;
6. Ten zoneless triaxines.

TABLE B.—JANAL POLES OF 12-ACRAL 12-EDRA.

Zoned polar faces: 2-zoned, (4) = 2:
Zoned polar summits: 2-zoned, (4) = 2:
Zoneless polar faces; 2-ple, (6) = 2, (4) = 7:
Zoneless polar summits; 2-ple, (6) = 2, (4) = 7:
Zoned polar edges: (44) = 1, (33) = 1.
Homozone polar edges: (55) — 1, (44) = 2, (33) = 1.
Zoneless polar edges: (55) = 8, (44) = 18, (33) = 18.

TABLE C.—JANAL MONOZONE FEATURES.

Ja. monozone faces: (6) = 3, (5) = 9, (4) = 5, (3) = 15.
Ja. monozone summits: (6) = 3, (5) = 9, (4) = 5, (3) = 15.
Ja. epi. edges: (46) = 5, (35) = 9, (44) = 1, (34) = 1, (33) = 2.
Ja. zonal edges: (55) = 2, (44) = 9, (33) = 6.

TABLE D.—JANAL ANAXINE FEATURES.

Janal anaxine faces: (6) = 2, (5) = 22, (4) = 66, (3) = 98.
Janal anaxine summits: (6) = 2, (5) = 22, (4) = 66, (3) = 98.
Janal anaxine edges: (46) = 5, (55) = 4, (45) = 50, (44) = 42, (36) = 14, (35) = 66, (34) = 121, (33) = 41.

One zoned triaxine of Table A is :—

$A_1A_2A_3A_4$, $A_1A_2B_2$, $A_3A_4b_1$, $A_1B_2B_1a_2$, $A_3B_2B_1a_4$, $A_2A_3a_1a_4$,
$a_1a_2a_3a_4$, $a_1a_2b_2$, $a_3a_4B_1$, $a_1b_2b_1A_2$, $a_3b_2b_1A_4$, $a_2a_3A_1A_4$.

There are two 2-zoned polar 4-gons, the first and sixth, and a zoned polar edge, B_1B_2. $A_1A_2A_3A_4$ is not four-zoned, because it has two edges, A_1A_2 in a triangle, and A_2A_3 in a 4-gon; and it is not $A_2A_3a_1a_4$, because the latter has no edge in a triangle. Each of the three 2-zoned axes is at right angles to the other two. There is a monozone 4-gon as well as triangle. The other zoned triaxine is the reciprocal of this; that is, it has for the account of its summits, in terms of its faces, exactly the above written.

The eighteen 2-ple monozone monaxines of Table A are the following :—

(a) $DC_1B_2B_1C_2$, DAc_2C_1, aB_2C_1, aB_1B_2, B_1aC_2, C_2c_1AD,
$dc_1b_2b_1c_2$, daC_2c_1, Ab_2c_1, Ab_1b_2, b_1Ac_2, c_2C_1ad.

This has a monozone pentace, pentagon and triangle on the epizonal B_1B_2, a zonal edge DA, and a zoneless polar edge C_1c_2. Ab_2c_1 is a janal anaxine triangle.

(b) $AB_1C_1C_2B_2$, AD_1B_1, AD_2B_2, $B_2D_2aC_2$, C_2aC_1, $C_1aD_1B_1$,
$ab_1c_1c_2b_2$, aD_2b_1, aD_1b_2, $b_2D_1Ac_2$, c_2Ac_1, $c_1AD_2b_1$.

Here is a monozone 6-ace, A; and D is a polar zoneless 4-ace. The epizonal C_1C_2 carries 5-gon and triangle.

(c) $AB_1C_1C_2B_2$, $Ac_2D_2B_1$, $Ac_1D_1B_2$, $D_1B_2C_2$, C_1aC_2, $D_1c_1b_1$,
$ab_1c_1c_2b_2$, $aC_2D_1b_1$, $aC_1D_2b_2$, $D_2b_2c_2$, c_1Ac_2, $D_2C_1B_1$.

Here are a monozone 4-ace A, a pentagon and triangle on the epizonal C_1C_2, and a zoneless polar 4-ace D.

(d) $AB_1C_1C_2B_2$, ADc_2b_2, ADc_1b_1, Ab_1B_2, B_1ab_2, C_1dC_2,
$ab_1c_1c_2b_2$, adC_2B_2, adC_1B_1, aB_2b_1, B_1Ab_2, c_1Dc_2.

B_1b_2 is here the zoneless polar edge. There is a zoned edge AD, and an epizonal C_1C_2.

(e) $AB_1C_1C_2B_2$, Adc_2B_1, Adc_1B_2, $B_1b_2C_1$, C_1DC_2, $C_2b_1B_2$,
$ab_1c_1c_2b_2$, aDC_2b_1, aDC_1b_2, $b_1B_2c_1$, c_1dc_2, $c_2B_1b_2$.

Here is a zonal edge Ad, an epizonal C_1C_2, and a zoneless polar edge B_1b_2.

(f) $AB_1C_1C_2B_2$, Adc_2B_1, Adc_1B_2, $B_1c_2C_1$, C_1DC_2, $C_2c_1B_2$,
$ab_1c_1c_2b_2$, aDC_2b_1, aDC_1b_2, $b_1C_2c_1$, c_1dc_2, $c_2C_1b_2$.

The zoneless polar edge here is C_1c_2.

(g) $A_1A_2c_1B_1B_2C_2$, $A_1A_2b_2b_1$, $A_1C_1C_2$, $C_2a_2B_2$, $B_1a_1c_1$, $c_1c_2A_2$,
$a_1a_2C_1b_1b_2c_2$, $a_1a_2B_2B_1$, $a_1c_1c_2$, $c_2A_2b_2$, $b_1A_1C_1$, $C_1C_2a_2$.

Here are two epizonals, B_1B_2, A_1A_2, both (64). The zoneless polar edge is C_1C_2, joining 4-aces.

(h) $A_1A_2c_1B_1B_2C_2$, $A_1A_2b_2b_1$, $A_1a_2C_2$, $C_2B_2a_2$, $B_1a_1c_1$, $c_1a_1A_2$,
$a_1a_2C_1b_1b_2c_2$, $a_1a_2B_2B_1$, $a_1A_2c_2$, $c_2b_2A_2$, $b_1A_1C_1$, $C_1A_1a_2$.

This differs from the preceding, in having the polar zoneless A_2a_1 joining 5-aces.

The preceding eight, with their reciprocals, make sixteen 2-ple monaxine monozones. It is easy to form a reciprocal, say of (h). Let the faces in the upper line be called $GHI_1J_1J_2I_2$, and let $ghi_1j_1j_2i_2$ be those of the lower. Then $A_1 = GHj_2i_2I_1$; for A_1A_2 is read a second time in H; A_1b_1 a second time in j_2; A_1C_1 a second time in i_2; A_1a_2 a second time in I_1; and A_1C_2 leads back to G. Thus all the twelve summits can be formed in terms of the faces, from inspection of (h), if we pass always from an edge of a summit to a contiguous edge.

The seventeenth and eighteenth are (i) and (j) following:—

(i) $AB_1C_1C_2B_2$, ADB_1, $B_1b_2dC_1$, C_2dC_1, $C_2db_1B_2$, B_2DA,
Autop. $ab_1c_1c_2b_2$, adb_1, $b_1B_2Dc_1$, c_2Dc_1, $c_2DB_1b_2$, b_2da.

This has the zonal edge AD, and the epizonal C_1C_2, the former in two triangles, the latter in a 5-gon and triangle.

The zoneless polar edge is B_1b_2 in two 4-gons and in two 4-aces. The solid is *autopolar*, or its own reciprocal; so that the result of constructing the reciprocal will be the same (i).

(j) $A_1B_1A_2B_2$, $A_1c_2B_1$, $A_2C_1b_2B_1$, $A_2C_2b_1B_2$, $A_1B_2c_1$, $A_1c_1a_2c_2$,
Autop. $a_1b_1a_2b_2$, $a_1C_2b_1$, $a_2c_1B_2b_1$, $a_2c_2B_1b_2$, $a_1b_2C_1$, $a_1C_1A_2C_2$.

This has two different zoned summits, A_1A_2, 4-aces, about either of which two opposite faces are zoned 4-gons, as $A_1B_1A_2B_2$ and $A_1C_1A_2C_2$ about A_2. The zoneless polar edge is B_1b_2, in two 4-aces and two 4-gons. This (j) is also autopolar.

The 24 janal anaxine solids are the first two next written autopolars, and the eleven following, with their reciprocals, easily formed.

(k)	ABCDE,	BfC,	CfeD,	DabE,	EdA,	FEb,
Autop.	abcde,	bFc,	cFEd,	dABe,	eDa,	feB.
(l)	ABCDEF,	ABe,	BeC,	CeD,	DfaE,	EFd,
Autop.	abcdef,	abE,	bEc,	cEd,	dFAe,	efD.
(m)	ABCDE,	ABef,	BeC,	CDFa,	DEF,	EcA,
	abcde,	abEF,	bEc,	cdfA,	def,	eCa.
(n)	ABCDE,	AEf,	AdeB,	BeC,	CFaD,	Efc,
	abcde,	aeF,	aDEb,	bEc,	cfAd,	eFC.
(o)	ABCDE,	AEf,	AcdB,	BeFC,	DEb,	cfA,
	abcde,	aeF,	aCDb,	bEfc,	deB,	CFa.
(p)	AFCDE,	FCB,	CDae,	DbE,	AdBF,	CeB,
	afcde,	fcb,	cdAE,	dBe,	aDbf,	cEb.
(q)	ABCDE,	BCf,	CbD,	DEb,	AEbF,	ABcF,
	abcde,	bcF,	cBd,	deB,	aeBf,	abCf.
(r)	ABCDE,	ABf,	BCed,	CDbF,	AcE,	Acf,
	abcde,	abF,	bcED,	cdBf,	aCe,	aCF.

(s) ABCDE, ABF, AEdF, EcfD, DeC, CFB,
abcde, abf, aeDf, eCFd, dEc, cfb.

(t) ABCDE, AFB, EbfD, DeC, CeB, AFdE,
abcde, afb, eBFd, dEc, cEb, afDe.

(u) ABCDE, ABed, BfC, CfD, EbFA, Daf,
abcde, abED, bFc, cFd, eBfa, dAF.

(v) ABCDE, ABe, BCf, CDaef, DaE, Bef,
abcde, abE, bcF, cdAEF, dAe, bEF.

(w) ABCDE, DEf, AEf, CDfba, FCa, FCB,
abcde, deF, aeF, cdFBA, fcA, fcb.

The solids (v) and (w) are not the same; for ae, the intersection of two pentagons in (v) is in the 5-ace e. But in (w) neither CD nor AB is in a 5-ace.

The homozone triaxines 4, Table A, are the two following (H) (h) and their reciprocals:—

(H) $A_2A_1B_4C_4B_1$, $A_2A_1B_3C_3B_2$, $A_2B_1C_1$, $A_2B_3C_1$, $A_1B_4C_2$, $A_1B_3C_3$,
$a_1a_2B_2C_1B_1$, $a_1a_2B_3C_3B_4$, $a_1B_1C_4$, $a_1B_4C_4$, $a_2B_2C_2$, $a_2B_3C_3$.

The janal zoned polar edges are A_1A_2 and a_1a_2; and B_1, &c., are the four like zoneless polar summits, not janal.

A and C are monozone 4-ace and triace.

(h) $A_2A_1B_1B_2$, $A_1A_2B_3B_4$, $B_4A_1B_1$, $B_3A_2B_2$, $B_1B_2b_4b_3$, $B_3B_4b_2b_1$,
$a_2a_1b_3b_2$, $a_1a_2b_1b_4$, $b_4a_1b_3$, $b_1a_2b_2$, $b_1b_4B_2B_3$, $b_2b_3B_1B_4$.

The janal zoned polar edges are A_1A_2 and a_1a_2; and B_1b_3, &c., are the four zoneless polar edges, all alike, and non-janal.

On the epizonal B_1B_2, are two monozone 4-gons, and on the epizonal b_3b_4, are a monozone triangle and one of these 4-gons.

The 2-ple janal monaxines 5, Table A, are one autopolar, first below written, and two more with their two reciprocals:—

$A_1A_2C_2B_2$, $A_2A_1C_1B_1$, $A_1C_1b_1c_1$, $A_2C_2b_2c_2$, $A_1B_2c_1$, $A_2B_1c_2$.
Autop. $a_1a_2c_2b_2$, $a_2a_1c_1b_1$, $a_1c_1B_2C_2$, $a_2c_2B_1C_1$, $a_1b_2C_2$, $a_2b_1C_1$.

A_1A_2 and a_1a_2 are the zoneless polar edges in 4-gons and 4-aces.

$$A_1A_2B_1D_2D_1,\ A_2A_1B_2D_4D_3,\ A_1B_2D_1,\ A_2B_1D_3,\ D_1B_2D_4,\ D_2B_1D_3,$$
$$a_1a_2b_1D_3D_2,\ \ a_2a_1b_2D_1D_4,\ \ a_1b_2D_2,\ \ a_2b_1D_4,\ \ D_2b_2D_1,\ \ D_2b_1D_4.$$

$$A_1A_2b_1C_2,\ A_1A_2C_1B_1,\ A_1B_1b_2C_2,\ A_2b_1B_2C_1,\ B_1B_2C_1,\ b_1b_2C_2,$$
$$a_1a_2b_2c_2,\ \ a_1a_2c_1B_2,\ \ a_1B_2B_1c_2,\ \ a_2b_2b_1c_1,\ \ b_1B_2c_1,\ \ B_1b_2c_2.$$

The zoneless polar A_1A_2, a_1a_2, in the former of these is in two triaces and two pentagons, and that of its reciprocal will be in two triangles and two pentaces.

The polar A_1A_2 of the latter is in two triaces and two 4-gons, and has a reciprocal whose polar edge is in two 4-aces and two triangles.

The ten zoneless triaxines of Table A, are two autopolars, first below written, and the four next following with their reciprocals :—

$$A_1A_2c_2B_1,\ A_1A_2b_1C_1,\ A_1B_2C_2C_1,\ A_2c_2c_1b_2,\ A_1B_1B_2,\ B_1B_2a_2,$$
Autop. $$a_1a_2c_1b_2,\ \ a_1a_2B_2C_2,\ \ a_2B_1c_2c_1,\ \ a_1C_2C_1b_1,\ \ a_1b_1b_2,\ \ b_1b_2A_2.$$

The three zoneless poles are the edges A_1A_2, B_1B_2, C_1C_2, the first in 4-aces and 4-gons, the second in 4-aces and triangles, the third in triaces and 4-gons.

$$A_1A_2B_1B_2C_1,\ A_2B_1C_2,\ A_2c_2a_2,\ B_2C_1a_1,\ A_1C_1a_1,\ a_1a_2C_2B_1B_2,$$
Autop. $$a_1a_2b_1b_2c_1,\ \ a_2b_1c_2,\ \ a_2C_2A_2,\ \ b_2c_1A_1,\ \ a_1c_1A_1,\ \ A_1A_2c_2b_1b_2.$$

The three polar edges are A_1A_2 in pentaces and pentagons, B_1B_2 in triaces and pentagons, and A_1a_1 in pentaces and triangles.

$$A_1B_1C_1A_2B_2C_2,\ A_2B_2a_1b_1,\ A_2b_1c_1,\ A_2c_1a_2,\ B_2C_2a_1,\ C_2a_1A_1,$$
$$a_1b_1c_1a_2b_2c_2,\ \ a_2b_2A_1B_1,\ a_2B_1C_1,\ a_2C_1A_2,\ b_2c_2A_1,\ c_2A_1a_1.$$

Here are a zoneless polar 6-gon and 4-gon, first written, and polar edge a_1A_1 in 5-aces and triangles.

$$A_1B_1A_2B_2,\ A_1B_2c_2c_1,\ A_2B_1C_1C_2,\ A_2B_2C_2,\ A_1B_1c_1,\ B_1C_1b_1c_1,$$
$$a_1b_1a_2b_2,\ \ a_1b_2C_2C_1,\ \ a_2b_1c_1c_2,\ \ a_2b_2c_2,\ \ a_1b_1C_1,\ \ b_2c_2B_2C_2.$$

Here are two different zoneless polar 4-gons, the first and last, and a polar edge C_1C_2, in 4-aces and 4-gons.

$$A_1A_2B_1c_1C_1,\ A_1A_2C_2c_2b_2,\ A_1b_1C_1,\ A_2B_1B_2,\ A_2B_2C_2,\ A_1b_1b_2,$$
$$a_1a_2b_1C_1c_1,\ a_1a_2c_2C_2B_2,\ a_1B_1c_1,\ a_2b_1b_2,\ a_2b_2c_2,\ a_1B_1B_2.$$

A_1A_2, B_1B_2, and c_1C_1, are the three zoneless poles.

$$A_1D_2C_1C_2,\ A_2D_1C_2C_1,\ A_2C_1D_2B_2,\ A_2c_1d_2B_1,\ A_1B_1d_2,\ A_2B_1D_1,$$
$$A_2d_1c_2c_1,\ A_1d_2c_1c_2,\ A_1c_2d_1B_2,\ A_1C_2D_1B_1,\ A_2B_2d_1,\ A_1B_2D_2.$$

A_1 is polar hexace, B_1 polar 4-ace, and C_1C_2 polar edge.

Nothing is easier than to turn these literal into linear constructions upon any faces chosen.

I shall content myself with making, as above, abstracts of my tables for the remaining 12-edra. I could give the construction of all the solids, for the construction of them is a bagatelle compared with their enumeration in their detailed symmetry; but I cannot see what use it would serve to do so. A collection of pictures of the polyedra is no exposition of the theory, not even of their enumeration; for still after the necessary proofs were added that no two solids drawn were alike, the grand difficulty would remain, the demonstration that there are no more. My tables are rigorously that demonstration, and, I fear, the simplest within the reach of present geometry.

Some eighteen years ago I cut my solitary way into this thorny theory in all directions by thorough roads not remarkable for smoothness. What I have above given of literal construction with explanations will suffice for any qualified student who has a fancy to prove or disprove my results by easier and shorter paths. No doubt it can be done, although I am unable to guess how. The subject, like many others, must wait till accident or fashion makes it a sublunary topic. Meanwhile let us peg away at Sphæria, Stigmaria, Migratory Cells, and Geometry of four or five dimensions.

JANAL 14-ACRAL 12-EDRA.

TABLE A.—THE JANAL SOLIDS OF THE 14-ACRAL 12-EDRA.

1. One zoned Triarchaxine.
2. Four three-zoned Monarchaxine homozones.
3. Twenty-three 2-ple monaxine monozones.
4. One zoned triaxine.
5. Sixty-four janal anaxine solids.
6. One six-zoned Monarchaxine homozone.
7. Two three-zoned Monarchaxines.
8. Two homozone triaxines.
9. Three 2-ple janal monaxines.
10. Ten zoneless triaxines.

TABLE B.—JANAL POLES.

Polar summits.—6-zoned homozone, (6) = 1.
" " 3-zoned, (3) = 2.
" " 4-zoned, (4) = 1.
" " 2-zoned homozone, (6) = 1, (4) = 1.
" " 3-zoned homozone, (6) = 1, (3) = 4.
" " 2-ple zoneless, (4) = 17, (6) = 1.
Polar faces.—2-zoned, (4) = 1.
" " 2-ple zoneless, (6) = 2, (4) = 4.
Polar edges.—Zoned, (55) = 1, (44) = 1.
" " Zoneless, (66) = 3, (55) = 17, (44) = 15, (33) = 4.

TABLE C.—JANAL MONOZONE FEATURES.

Monozone faces.—(7) = 4, (6) = 3, (5) = 18, (4) = 10, (3) = 24.
Monozone summits.—(6) = 2, (5) = 2, (4) = 23, 3 = 17.
Zonal edges.—(55) = 8, (44) = 8, (33) = 5.
Epizonal edges.—(37) = 4, (46) = 2, (55) = 2.
" " (36) = 2, (45) = 2, (44) = 1.
" " (35) = 11, (34) = 5, (33) = 1.

TABLE D.—JANAL ANAXINE FEATURES.

J. A. faces, (7) = 2, (6) = 30, (5) = 88, (4) = 146, (3) = 161.
J. A. summits, (6) = 1, (5) = 33, (4) = 141, (3) = 335.
J. A. edges, (47) = 16, (56) = 41, (46) = 73, (55) = 50.
" " (37) = 10, (45) = 154, (36) = 76, (44) = 91.
" " (35) = 164, (34) = 164, (33) = 48.

The only constructions that I shall give are the triarchaxine and a 3-zoned monarchaxine, two species not so described before. The triarchaxine is :—

$A_1B_1A_2B_2$, $A_1B_1A_4B_3$, $A_1B_2A_3B_3$, $A_2B_2a_4b_3$, $A_2B_1a_3b_2$, $A_3B_2a_4b_1$,
$a_1b_1a_2b_2$, $a_1b_1a_4b_3$, $a_1b_2a_3b_3$, $a_2b_2A_4B_3$, $a_2b_1A_3B_2$, $a_3b_2A_4B_1$.

There are six principal poles B, 4-zoned 4-aces, in three principal axes, four secondary janal homozone 3-zoned axes, carrying the eight 3-zoned triaces A, and six tertiary two-zoned janal axes, carrying the twelve 2-zoned polar 4-gons of the solid, whose zonal traces are their two diagonals. There is but one edge, a janal zonal, and but one face.

A 3-zoned monarchaxine is :—

$AB_1C_2C_1B_3$, $AB_3C_6C_5B_2$, $AB_1C_3C_4B_2$, $B_1C_2C_3$, $B_2C_4C_5$, $B_3C_6C_1$,
$ab_1C_2C_1b_3$, $ab_3C_6C_5b_2$, $ab_1C_3C_4b_2$, $b_1C_2C_3$, $b_2C_4C_5$, $b_3C_6C_1$.

The principal janal axis carries the 3-zoned triace A. The secondary non-janal axis carries the zoned polar edges, not janal, C_1C_2 in monozone pentagons, and C_4C_5 in monozone triangles. There are three secondary axes. B is a non-janal monozone triace, and C is an asymmetric 4-ace.

The 6-zoned monarchaxine homozone is made by crowning a 12-gon with a 6-ace on the summits 1, 3, 5, ... and at the opposite face with a 6-ace on 2, 4, 6, ...

JANAL 16-ACRAL 12-EDRA.

TABLE A.—THE JANAL SOLIDS.

1. Thirty-five 2-ple monaxine monozones.

2. Three zoned triaxines.
3. Sixty-eight janal anaxine solids.
4. Fifteen zoneless triaxines.
5. Eight 2-ple janal monaxines.
6. Five homozone triaxines.

Table B.—Janal Poles of 16-Acral 12-Edra.

Polar faces.—Zoneless 2-ple, (6) = 6, (4) = 17.
Polar summits.—Zoned, 2-zoned, (4) = 2.
" " Zoneless 2-ple, (4) = 8.
Polar edges.—2-zoned, (66) = 2, (55) = 2, (44) = 3.
" " Homozone, (77) = 1, (66) = 1, (55) = 1, (44) = 2.
" " Zoneless 2-ple (77) = 2, (66) = 11, (55) = 23, (44) = 19, (33) = 7.

Table C.—Monozone Janal Features of 16-Acral 12-Edra.

Faces.—(8) = 4, (7) = 7, (6) = 11, (5) = 17, (4) = 21, (3) = 21.
Summits.—(5) = 11, (4) = 6, (3) = 46.
Epizonal edges.—(37) = 7, (46) = 8, (55) = 3, (48) = 4, (66) = 2.
" " (36) = 2, (45) = 2, (35) = 7, (44) = 4, (34) = 5.
Zoned edges.— (66) = 3, (55) = 13, (44) = 9, (33) = 3.

Table D.—Janal Anaxine Features of 16-Acral 12-Edra.

J. A. faces.—(7) = 15, (6) = 62, (5) = 116, (4) = 136, (3) = 143.
J. A. Summits.—(5) = 9, (4) = 139, (3) = 509.
J. A. edges.—(84) = 10, (83) = 4, (75) = 42, (74) = 49.
" " (73) = 35, (66) = 28, (65) = 117, (64) = 108.
" " (63) = 119, (55) = 62, (54) = 164, (53) = 145, (44) = 68, (43) = 101, (33) = 20.

The 68 janal anaxines 16-acral 12-edra may be thus

described, for the assistance of any student who may desire to construct them :—

$$(7^2 5^2 4^4 3^4) = 12,\ (7^2 5^4 3^6) = 2,\ (7^2 4^8 3^2) = 1.$$
$$(6^4 5^2 3^6) = 7,\ (6^4 4^4 3^4) = 6,\ (6^2 5^4 4^2 3^4) = 20.$$
$$(6^2 5^2 4^6 3^2) = 18,\ (5^6 4^4 3^2) = 7:$$

where the exponents are merely multipliers; *i.e.*, we read that there are 12 of the 68 solids which have a 7-gon, a 5-gon, two 4-gons, and 2 triangles; each face opposite to its reflected image, none being either zoned or polar. If the two 4-gons or the two triangles differ, there will be no zone: if one reflects the other, the construction is zoned.

JANAL 18-ACRAL 12-EDRA.

TABLE A.—THE JANAL SOLIDS.

1. Two 4-zoned Monarchaxines.
2. Two zoned triaxines.
3. Eighteen 2-ple monaxine monozones.
4. Thirty-eight janal anaxine solids.
5. Two homozone triaxines.
6. Five zoneless triaxines.
7. One 2-ple janal monaxine.

TABLE B.—JANAL POLES OF 18-ACRAL 12-EDRA.

Zoned polar faces, 2-zoned.—(8) = 1, (6) = 1, (4) = 2.
" " summits, 4-zoned.—(4) = 2.
" " homozone, 2-zoned.—(4) = 2.
Zoneless polar summits, 2-ple.—(4) = 7.
Zoned polar edges.—(66) = 1, (55) = 8.
Zoneless polar edges.—(77) = 8, (66) = 11, (55) = 8, (44) = 4.

TABLE C.—JANAL MONOZONE FEATURES.

Monozone faces.—(9) = 1, (8) = 1, (7) = 8, (6) = 4, (5) = 12, (4) = 8, (3) = 14.

Monozone summits.—(4) = 17, (3) = 24.

Janal zonal edges.—(66) = 5, (55) = 5, (44) = 4, (33) = 3.

Janal epizonal edges.—(39) = 1, (48) = 1, (57) = 2, (38) = 1,
(47) = 1, (56) = 1, (37) = 5, (55) = 1,
(46) = 1, (36) = 2, (45) = 2, (35) = 2,
(44) = 1, (34) = 3.

Table D.—Janal Anaxine Features of 18-Acral 12-Edra.

Ja. an. faces.—(8) = 4, (7) = 19, (6) = 49, (5) = 60, (4) = 66,
(3) = 62.

Ja. an. summits.—(4) = 38, (3) = 370.

Ja. an. edges.—(67) = 36, (58) = 15, (49) = 4, (66) = 31.
" " (75) = 48, (48) = 15, (65) = 65, (47) = 37.
" " (38) = 7, (55) = 31, (46) = 67, (37) = 36.
" " (45) = 74, (36) = 66, (44) = 23, (35) = 50,
(34) = 32, (33) = 3.

JANAL 20-ACRAL 12-EDRA.

Table A.—The Janal Solids.

1. One zoned Hexarchaxine.
2. One ten-zoned Monarchaxine.
3. Two three-zoned Monarchaxine homozones.
4. Ten 2-ple monaxine monozones.
5. Four zoned triaxines.
6. Four janal anaxine solids.
7. Six homozone triaxines.
8. Two 2-ple janal monaxines.
9. Three zoneless triaxines.

Table B.—Janal Poles of 20-Acral 12-Edra.

Zoned pol. faces.—10-zoned, (10) = 1; 5-zoned, (5) = 1.
" " 2-zoned, (8) = 2 (6) = 1, (4) = 4.

Homozone pol. summits.—3-zoned, (3) = 2.
Ja. zoneless 2-ple pol. faces.—(8) = 1, (6) = 3, (4) = 2.
Ja. zoned pol. edges.—(66) = 4, (55) = 2, (44) = 2.
Homozone pol. edges.—(88) = 1, (66) = 2, (55) = 1, (44) = 2.
Ja. zoneless pol. edges.—(88) = 2, (77) = 6, (66) = 5, (55) = 6, (44) = 3.

Table C.—Janal Monozone Features.

Ja. monozone faces.—(9) = 1, (8) = 2, (7) = 5, (6) = 7.
" " (5) = 6, (4) = 8, (3) = 9.
Ja. monozone summits.—(3) = 29.
Ja. zoned edges.—(66) = 4, (55) = 3, (77) = 3, (44) = 2.
Ja. epizonals.—(10 4) = 1, (86) = 2, (84) = 3, (93) = 1, (57) = 2, (65) = 1, (74) = 1, (38) = 1, (64) = 4, (45) = 2, (36) = 2, (44) = 2, (34) = 3.

Table D.—Janal Anaxine Features of 20-Acral 12-Edra.

Ja. an. faces.—(8) = 1, (7) = 6, (6) = 7, (5) = 10, (4) = 8, (3) = 8.
Ja. an. summits.—(3) = 89.
Ja. an. edges.—(38) = 3, (37) = 11, (36) = 9, (35) = 7, (34) = 3, (45) = 10, (46) = 12, (47) = 10, (48) = 3, (49) = 2, (55) = 4, (56) = 13, (57) = 10, (58) = 7, (59) = 2, (67) = 16, (68) = 4, (77) = 2, (66) = 2.

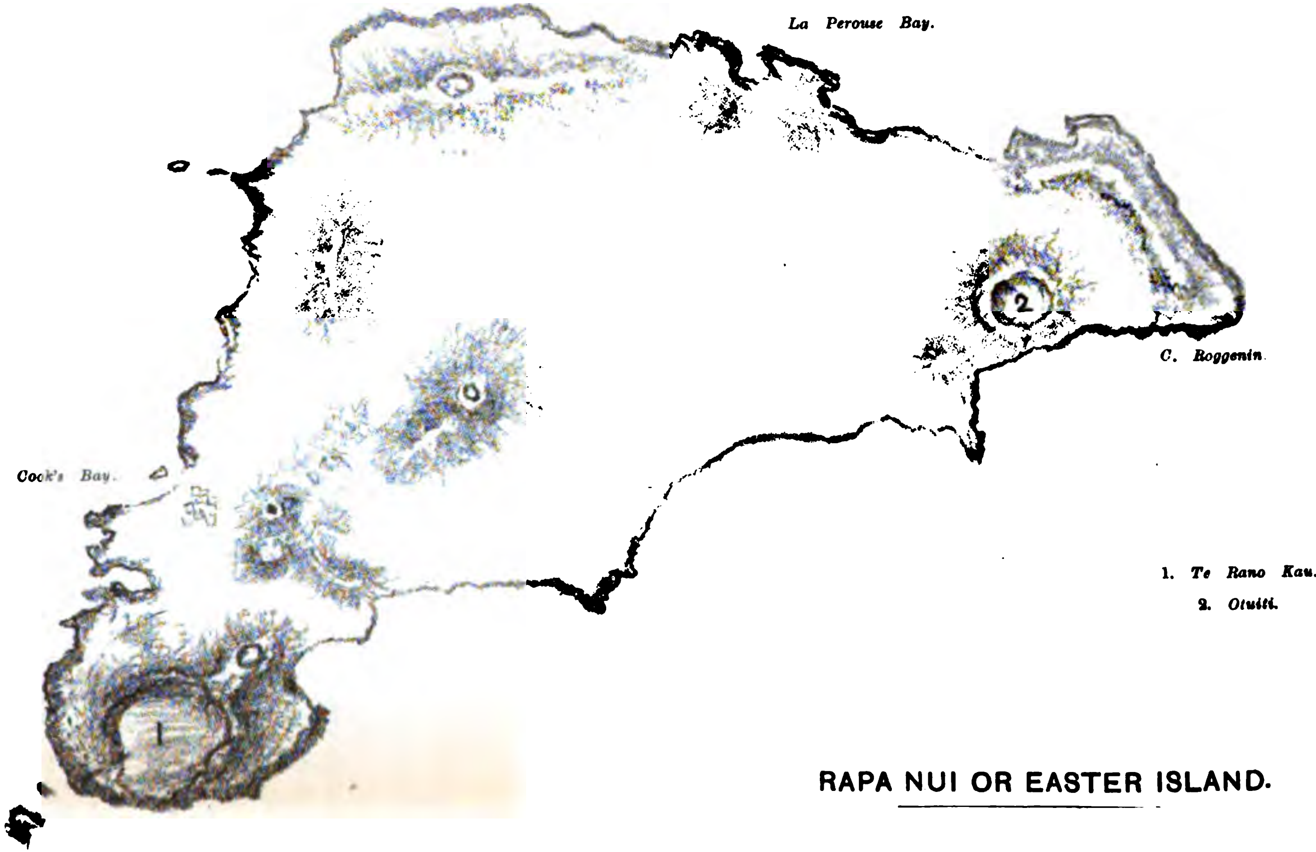
ADDENDUM.

The entry No. 7 in Table A of 14-acral 12-edra, page 268, should be *Three three-zoned Monarchaxines*, instead of *Two*. The 3-zoned monarchaxine constructed at page 269 becomes a second of the three, if, retaining the six pentagons, we put for the six triangles the six

$$B_1C_2b_1,\ B_2C_4b_2,\ B_3C_6b_3,$$
$$b_1C_3B_1,\ b_2C_5B_2,\ b_3C_1B_3.$$

The third solid is easily constructed on the 12-acral prism.

I have forgotten also to give the only janal 12-edra which have an odd number of summits, namely, three 11-acral 3-zoned monarchaxines, and one 17-acral 3-zoned monarchaxine. Two of the former are what the two above described become by the convanescence of the polar edges C_1C_2, whereby the six pentagons are reduced to six tetragons: the third is easily constructed on the wedge, *i.e.*, the 6-acral prism. The 17-acron is readily formed on the same wedge. The inadvertence of these omissions has been possible from the reason that the janal solids missed have no janal anaxine features, the enumeration of which is a leading difficulty of the theory, and mainly occupied me.



RAPA NUI OR EASTER ISLAND.

DAVIS OR EASTER ISLAND.

By J. LINTON PALMER.

Davis, or Easter, Island — Rapa-nui, native name — was discovered by the English buccaneer Davis, in 1686; thirty-six years after, the Dutchman Roggewin visited it, and as he sighted it on Easter day, called it Paasen, or Easter Island, the name by which now it is generally known.

Its position is most isolated, being in the Mid-South Pacific ocean, about 2,000 miles west of Valparaiso and Lima, 1,000 east of the famous Pitcairn's Island and the Gambier group, and about 1,900 in the same direction both from Tahiti and a small island, Rapa-iti or Oparo, lately a coaling station on the Panama and New Zealand line. To this island I shall presently refer.

It may be called a mass of volcanoes, but these have been extinct for such ages that, in the huge crater of one, Te Rano Kau, which is a mile in diameter, and eight hundred feet deep, twenty-six feet of water were sounded by the officers of H.M.S. *Topaze*, in the pools found in the boggy soil accumulated there.

Its size is about half that of the Isle of Wight, to which, in its outline, it bears a certain resemblance; the hills, which are not over 1,500 feet in height, being rounded, and bluff cliffs terminating it at either end.

Its coasts are lashed by a furious surf, so that attempts to land at the practicable points will be found, frequently, not only hazardous, but even impossible. All visitors concur in this.

Even after landing, it is not an inviting place to walk

over, as the soil is everywhere strewn with loose angular lumps of very hard lava; and, as the native paths are in size just broad enough to let one foot go before the other, the swinging gait this necessitates is both irksome and tiring to a European. We found it so, to our cost. The air, also, is very dry, so the natives always carry sugar-cane to champ. *We* wanted water, which is not always to be got.

The soil is composed of rotten lava, mixed with vegetable mould, and naturally is very fertile, requiring but little toil to give the food necessary for the requirements of savage life. Sweet potato, of most exquisite quality; yam, sugar-cane, plantain, all grow abundantly, if cared for. Besides, there is an indigenous gourd, which serves for water-bottles.

Flora.—As for trees, I cannot call the shrubs and bushes I saw by that name. There are none now, though, from the boles and roots found in some places, they must have existed.

1. The Acacia, called Toro-miro (three wood), which grows in Chile to a large size. It is there called Pulen. From this the small images and tablets, rapas, batons, etc., are made. (Edwardsia McNabiana.)

2. The Tree Mallow, Hibiscus. (Pooréw, of the natives).

3. Paper Mulberry, Broussonetia Papyrifera (Màhuté).

4. Tij, Dracæna Terminalis, from which they make their javelin shafts; these are the large growths.

Ferns, sedge, rush, flag, and rank grass make what sailors call the green stuff.

Fauna.—There is but one native quadruped, the ordinary Polynesian rat (Kive-Kive).

No land birds, except the common fowl.

I do not know of the existence of any reptile.

There are very few insects — a butterfly or two, a beetle or two, and, it is said, the centipede. There was, in some

places, a perfect pest of flies. I was only too glad to escape from their attentions, without collecting a hostage to identify their tribe. In the grottoes of Anakena fleas were numerous and troublesome.

Yet in this, by description, most commonplace and undesirable island, in which, also, early navigators said no fresh water was to be found, are found things which are puzzling to many.

Curiously sculptured stones, tribe burial places, mausolea of chiefs, on which their images, gigantic in size, hewn from hard lava, although now in ruin and decay, make the visitor wonder at the skill and perseverance shown in their erection by a once numerous and well-organised population; and lastly, I believe the only instance in Polynesia, the existence of tablets, made of very hard wood, on which a kind of picture-writing is incised, which, *some say*, is still able to be read, and refers to the credence, social state, land division, and to the history, as well as to the traditions, of the inhabitants.

Visitors.—Davis says nothing about the island worth recording.

Gonzales, who came in 1770, gives a few details. He alludes to the lack of animal and vegetable life, and to the habits of the inhabitants. One thing in particular he notices: the image of eight to nine feet high, with a white head-dress, named Geso-peca, probably "Hoa haka nana Ia," now in the British Museum.

Roggewin, 1772, told strange tales of huge giants, of dense woods, of fruit trees, of shaven priests, who at sunrise worshipped Taurico and Dago at altars fired at daybreak, and who bowed to the rising sun.

La Pérouse (1776), in the surgeon's remarks, says he

saw nothing of the giants, nor of the *thin* men. La Pérouse left on the island, hogs and other animals, as well as fruit trees. Nothing is noticed about the worship.

The other visitors — Cook, 1774, has given a good account, so good that it seems written a few years ago; Kotzebue, 1816; Beechey, 1826; H.M.S. *Portland*, 1853; *Le Cassini*, 1862; H.M.S. *Topaze*, 1868; the Chilian ship, 1870; and French *La Flora*, 1872, are among the more noticeable. The *Portland* sent two cutters, but could not land. Most of these did not land, till the *Cassini*, which even surveyed the island in two boats; but, in 1863, the Peruvians sent an expedition for the purpose of carrying off the islanders to serve as coolies, and dig the guano of the Chincha Islands. Their ships carried away some thousand of the natives, with the king, Ro Tepito, and the royal family.*

May, 1863, Père Albert Eyraud and Frère Eugène landed at Tahiti, on their way to the island, as it was intended to establish a Mission there; but finding what the Peruvians had done, Fr. Eugène proceeded by himself, in January, 1864, though the small-pox was raging in the island, and began his labours.

In Nos. 224, 225, of the *Annales de la Propagation de la Foi*, is his letter to his superior-general in Paris, Père P. Olivier. It gives a good description of the state of the natives, who treated him very badly. Even his life was sometimes in danger, till a chief, Torometi, took him under his protection.

Eight months after this he was taken to Tahiti in a vessel, sent for him by the bishop, but, undeterred, returned, accompanied by Père Roussel, the chief of the Mission at the time of our visit.

* One child of royal lineage, baptised Gregorio, was left on the island. He died in 1864, at the Mission House, from some kind of fever, we were told.

In another year, two missionaries from Valparaiso landed, Fr. Eugène dying shortly afterwards.

The results of the raid of the Peruvians were most disastrous. As the king and royal family had been taken away, anarchy, theft, strife, murder, and famine were the natural consequences. The plantations were neglected, and the inhabitants diminished.

But if the damage done in the island was great, the fate of those natives who were carried away was more wretched. Unsuitable food, hard and unaccustomed toil, with coast fever of a low type, soon reduced their numbers to one-third; and when, by the exertions of the French consul, the survivors were restored to the island, they took with them the seeds of fevers and small-pox, which soon turned the place into one vast hospital.

Frère Eugène, at his arrival, numbered the people at 1,800; but in 1868 there were but 900. Two years subsequently, the Chilians found only 600; and the French, in 1872, that there were then between 300 and 400, a rapid form of pulmonary consumption, which, I was told, was quite unknown a few years before our visit, being one of the most fatal diseases.

Some of the islanders are now in the employ of planters at Tahiti, and no doubt there are others in various islands of the Society group.

No doubt, from this upset, our information as to the history, etc., of the islanders is so meagre.

Inhabitants.—All visitors have borne the same testimony as to the appearance of the natives. They were strong, and well made, tall, the features more resembling European than the ordinary Polynesian. They were fairer, some almost white. Some had red hair. The good looks of the women, and their vivacity, have been commented on by all.

They were lazy, good tempered, fond of finery and amusement, excellent mimics, expert carvers, and made very good mats and nets; but then they were very thievish, and distrusted one another.

Customs.—The men painted their bodies with earth of various colours, mixed with the sap of a plant; the women used red colouring only. Tattooing was practised by both sexes, the women being more elaborately adorned; and they have the custom, as in many parts, of making a hole in the lobe of the ear, and wearing in it a roll of sugar-cane leaf, a shark's vertebra, a piece of wood, and so forth, till it is greatly elongated.

They circumcised, and also shaved, using for this purpose razors of obsidian.

The women gathered the hair into a sort of knob or chignon; at the death of a chieftain, this hair was polled, and twisted into a thin string, from which the girdle of the men, a cord as thick as the little finger, and terminated by red tassels, was made.

The dress—first for both sexes, the Maro. For the men, a *blanket*, or mantle, which is fastened at the neck. This mantle was made of Tappa. The women used a petticoat of grass matting, which reached to the ankles.

They used diadems or crowns of the dark hackle, and metallic-looking feathers of the common fowl. They like red, but object otherwise to black cloth or ornaments.

Clubs, batons of office, carved figures, and images were found in their houses in great numbers.

Their cookery was simple. They killed the animal by stunning it, as they disliked the sight of blood, and cooked it by roasting it in a pit heated with stones, as usual in Polynesia.

Cannibalism was practised, and, as usual, more as a

religious ceremony than as an alimentary custom. I fear a good deal of misapprehension exists as to the reason of this disgusting act. The last time recorded was about 1863 or 1864, when four Spaniards were devoured.*

Their language is a dialect of that spoken at Tahiti, with a good many Malay words in it, as is common among these Southern Islanders. Many words have been altered since 1770, owing to the fashion, common in the South Seas, of *adopting* a word to serve for one that by some chance has been tabooed.

Burial.—The corpse was wrapped in a bale of sedge or grass, and placed, head seawards, on the Papakoo, or burial terrace. Sometimes it was lowered into the clefts of rocks overhanging the sea.

It seems strange, but suicide was not uncommon amongst them, and sometimes from very little cause. It is said that their belief in a future state of happiness helped this practice.

Marriage was not fixed by the parents, but by the parties themselves; and any quarrelling or strife was sufficient for a divorce, each party being then free to marry again.

In Creed they were Monotheists, believing themselves to be the offspring of a creator, Maké-Maké, who formed them from the earth, not by plastic operation, but as a plant grows. They do not make any effigy of this spirit-god, to whom, we have every reason to believe, they offered up human victims as burnt sacrifice.

* I have been assured there that, so far from the cannibal feasts in the South Sea Islands being a banquet, it was done only under strong excitement. The meal was highly seasoned, and provoked frequently nausea and illness. I am quite sure that there it is not practised from deficiency of animal food, as common fowls exist in plenty, and the Islanders do not seem to care much for them.

Polity.—The people were divided into tribes, with chieftains; but there was also a king, of hereditary succession, and a prime minister, who was obliged to be a celibate.

As well as these, there was another chief, whom we will call the war-minister. His term of office was for one year. For his election, almost all the people went to the great volcano, Terano-Kau, feasting for a month. The candidates had to descend the almost perpendicular cliffs (800 feet), swim to a rocky islet or two at a little distance, climb, and get from thence a sea-bird's egg. He who showed most ability and quickness was chosen.

The person of the king was sacred and inviolable. There was always a good deal of fighting among the tribes, the object being to get slaves.

Arms, etc.—Their arms were: A long lance, a light javelin; these were headed with obsidian; a club, and a short bludgeon-sword, like the méré of the New Zealanders. They were ignorant of the bow and sling. In their dances, they brandished, as a *thyrsus*, a double paddle of a strange shape, which they called Rapa. They wore gorgets of hard wood, lunate in shape, the ends terminating in heads, which varied very much in feature-outline. They used also balls of wood, carved into grotesque faces. The bâton of office of the chief was a stick about five feet long, as thick as the wrist, rather flattened, and ended at the top by a Janus head, with obsidian eyeballs. The bâton was not elaborately carved, as usual in many of the islands.

Remains.

Buildings.— The *papakoo*, or general cemetery, is a sloping terrace of sea-worn boulders, faced by a low wall of large stones, fitted together without cement, and the side walls are whitened.

Usually about 100 paces long. They are generally near the sea, but one I noticed was in a moated enclosure, and near it was a rude trunk image, like the small one in the British Museum, which was found at the Papakoo of Matavéri.

The Platforms, or Chiefs' Burial Places, are all pretty close to the sea, on headlands sloping landwards. Let me describe one.

First, seawards is a very stout wall, built of irregularly four-sided stones, fitted with great exactness without cement. Many of these are fully six feet long. It is difficult, from *débris* and sedge, to measure its height accurately, but it is about seven or eight yards.

It runs parallel to the shore, about one hundred paces long, by ten broad, is built flat and level at the top, where thin slabs, serving as pedestals, are placed for the images, the effigies, or memorial statues of the chiefs. Each of these had its name, with the affix of Ariki, or Chief, and Moai, said to mean Burial Place.

Landwards, the platform seemed only a yard or so high. Before it is a smooth sloping grass terrace, as long as the platform, but very much broader. This was also finished off in front and at the sides, by a low step of fitted stones, and joined the ends of the platform.

These platforms are strewn with human bones in all parts. These were old and weather-worn, but did not seem to have been burnt. The images all thrown down and mutilated. At Winipoo, we were able to enter the crypt, and found several skeletons there.

The Altar.—At a little distance from the terrace, and near the central line, was a pillar, or cylinder, of red tufa. It stood on an area paved with smooth boulders. It was placed on a pedestal made of the same kind of stone

as itself. It was about six feet in height, and about as much in diameter. The top was flat, cut away a little on each side so as to form a kind of step. On it were two skulls of youths, seemingly twelve or fourteen years old. They were very weather-worn, and the faces were placed looking towards the platform.

Cremation Stone.—Again, in a direct line landwards, and about a hundred yards away, was a saddle-topped pillar. These pillars were used for the offering of burnt sacrifice. The finest I saw was at Winipoo. It was a squared block of the same red tufa, about eight and a-half feet high. The top leaned forward, and ended in two *horns*, so to say, on each of which was traced, in low relief, a human head, with a saddle-shaped interval between them. It seemed, therefore, a two-headed man. The arms are rudely traced, as well as the fingers, which clasp the hips. The navel is very strongly marked. It stood on an area, paved in the same way as the altar. We found burnt bones there, and were distinctly told by the natives what was its use.

I almost wonder that this is not noticed by Captain Cook, as this is the platform he visited, and found the images on it erect; and he has given their names also.

Large Stone Images.—Of these there are some hundreds, of various sizes, not only on the platforms, but on the road from Otuiti, where they were all made. The stone is an easily wrought trachyte, but which resists the weather very well.

The largest are those at the crater of Otuiti. I measured one which was prostrate, 37 feet; those embedded in the soil, and erect, we judged to be 50. Gonzales says he found one of 54 feet, but the usual size of those on the platforms was 13 to 18, and there were little stump ones of only 4 or 5 feet. All the images face landwards.

Image
Easter Island,

The oldest in the island were inside the crater of Otuiti,* and they seemed to have a more Semitic expression of face than the others. The largest were outside the crater, and seemed either newer or not so weathered.

Close to the cave where we slept was a large block of lava, which was to form three of these images, the large one, 29 feet 9 inches long, and two shorter ones at its side, respectively 17 and 14 feet each, one in line with the other. The dimensions of the face of the large one: Forehead, 2 feet 7 inches; nose, 6 feet 8 inches; upper lip, 8 inches; lower lip and chin, 3 feet 8 inches. All three were still attached to the live rock.

These images are trunks, terminating at the hips; the arms are close to the side, the hands clasp the hips, and are cut in low relief.

They have all the same attitude and expression of face, which is square, massive, and sternly disdainful, the aspect always upwards. The peculiar feature is the extreme shortness of the upper lip, or the upthrust of the lower one, which produces the same effect. I noticed this action in the faces of the present inhabitants.

The eye-sockets are deep, and had eyeballs of obsidian inserted; the nose broad, nostrils expanded.

The ears were long, with pendant lobes. The profile varied somewhat in different images.

That which is now in the British Museum, Hoa-haka-Nana-Ia, is elaborately sculptured at the back of the head, with birds and rapas, and was painted red and white. The top of the head was cut flat, so as to allow the crown to be put on.†

* This group was drawn and sent by me to the *Illustrated London News*, who published it about six years since.

† Stewart says he found, in the Marquesas Islands, a statue smaller but very similar to those mentioned, made of wood (as there is no lava there), in a valley, between Taipee and Happar. It was called Haka-paa. Before it was a post, on which a dead dog was hung up.

Crowns.—These are called 'Häu, and are made of the same red tufa I have already mentioned, which is found in one crater only. Near its quarry I saw some twenty ready for removal. They vary in size from 10½ to 2 feet in diameter, and are very like a cheese in shape.

The Polynesian usually prefers the red flower or feather for his head-dress. In Sir G. Grey's *Polynesian Mythology*, you will find, "One of the chiefs said, 'There are more red ornaments for the head here than in Hawaiki.'" The girls at Pitcairn's used a red everlasting flower for their chaplets, at our visit, 1852.

Gonzales says, 1770, one image had on a white head-dress. As a coincidence, in Dr. Birch's *Records of the Past*, in the Hymn to Amun Ra (Part ii., p. 130):—

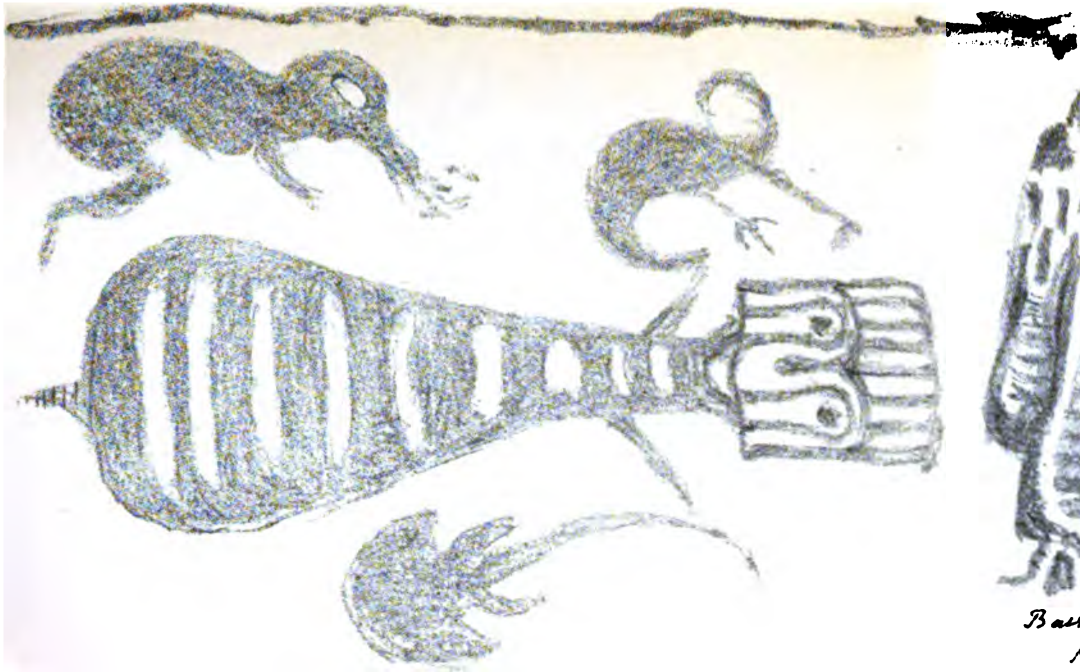
> "The double crown is his head-gear, he wears the red crown,
> Benignly he receives the atef crown;
> On whose south and on whose north is *love*."

> "Gracious ruler, crowned with the white crown."

On the base of some of these crowns which were at the quarry, I found some scribbling, as I thought. I copied some, and found lately among them one or two figures identical with the so-called signatures of the chiefs mentioned by Gonzales.

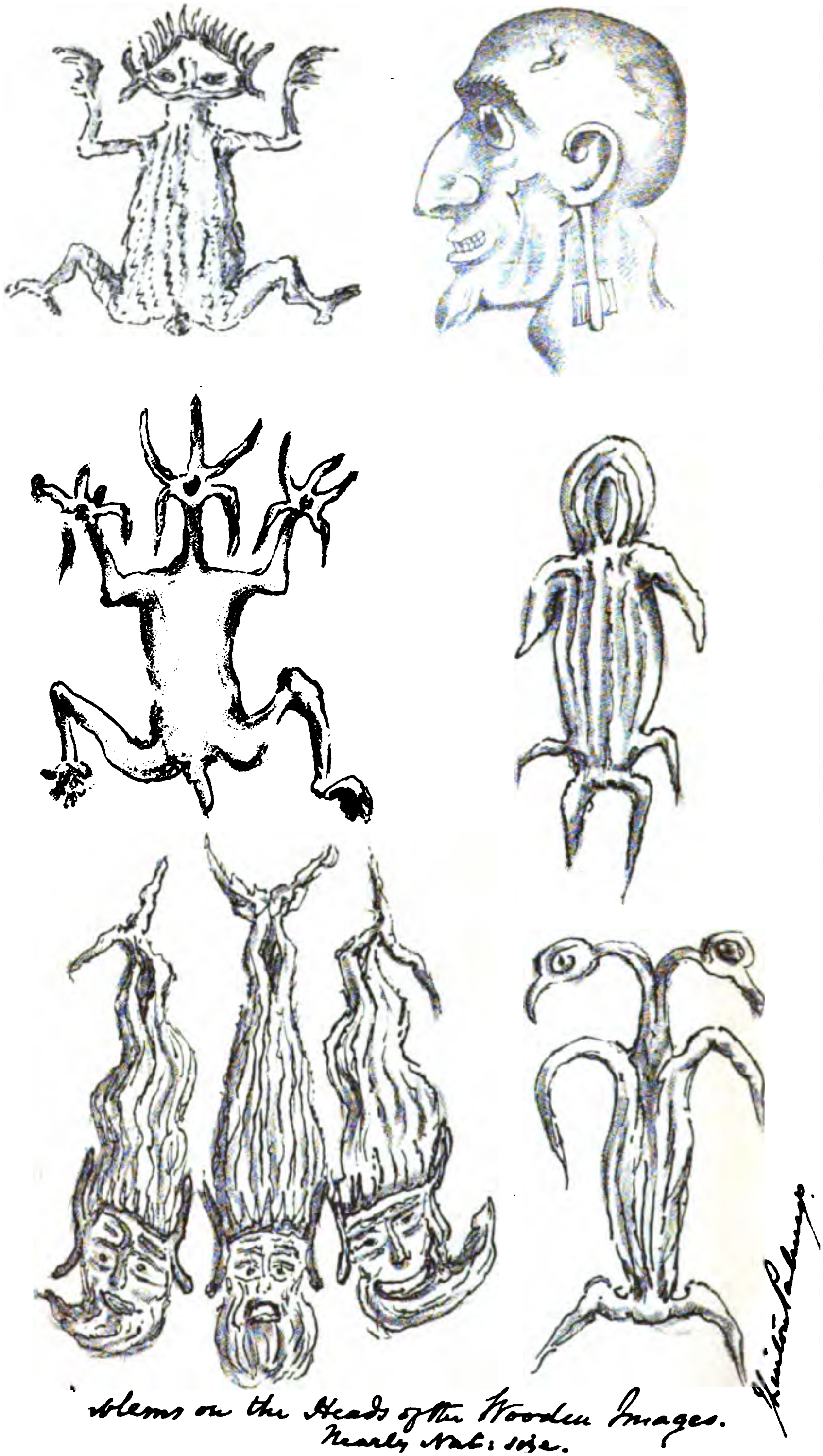
Chisel.—These all were cut with a chisel made of very hard lava, in shape like a rolling pin, or front tooth, held in the hand. There was only one we saw; it was called Ti-ngi-Ti-ngi (a very slight nasal sound), to represent the sound of its chipping.

Teraphs, or Wooden Images.—These, as a rule, are male figures, of about a foot in length. They are made of the only hard wood on the island (Toromiro). Those now made



Rapa, on a slab in one of the Stone Houses, J.L.P.

Back of the Head of Hoa Haka Nana Ia.



blems on the Heads of the Wooden Images.
Nearly Nat: size.

give one the idea of a very emaciated or flayed man; the profile strongly aquiline, the mouth grinning; ears with long lobes. Eyeballs of obsidian were put into the sockets, and a small tuft on the chin, for both sexes, *be it noted.* It is said, in Cook's time, they were *fatter.*

The female figures are much larger and flatter. The chin tuft is usually added; and as for profile, they are too *pancake* to notice it.

On the heads of the males are usually designed, in low relief, very extraordinary symbols, evidently mythic, such as a double-headed bird (in one case, on a female, something like the Russian eagle), a fish or cetacean, a merman, a lizard form, and some to which no likeness can be assigned, and which cannot have existed anywhere.

Besides these are smaller ones, very grotesque; a man with a toucan's bill in place of a nose, a fowl equally distorted, lizards, shark forms, and from their decay, these must have been of extreme age. They are in the possession of the then chaplain of H.M.S. *Topaze.*

These images were kept in the grass houses, either in niches, or suspended from the ridge-pole, and were carefully swathed in native cloth (or Tappa).

Small Images of Stone.—As well as these, small stone images were carved. Admiral Belcher says (1825) they were the ordinary ones. In the *Topaze's* visit, none were seen nor brought on board. The Chilians found and took away one or two very rude ones, but they had not the elongated ear lobe, though some of the wooden ones have normal ears.

Bas-reliefs of these same image-forms were found, and are now at Santiago, but they differ very much from either of the preceding types.

In the Fijis, and some other Islands, these same

small stone images are found—Sir G. Grey says in New Zealand; and though they are not worshipped, they bear some intrinsic value.

Wooden Images: their Meaning.—Although we are told, by the Jesuit Fathers, that without knowing the meaning of these images, the inhabitants still carve them, we may form some conjecture as to their use by tracing what is done by other Polynesians among whom they are found.

In the *Polynesian Mythology*—"Curse of Manaia"—Sir G. Grey, we find:—

"And just before night closed on them, she cast her garments on one side, girded herself with a new sash, made of the young shoots of the töe-töe tree, and standing on the threshold, spread out her gods, Kahu-kura, Itupawa, and Rongomai, and she stood before them. Their appearance was most propitious, and when her incantations were ended, she said, 'Your journey will be a most fortunate one.' The gods were then by her bound up in cloths, returned into the house, and hung up again."

Again:—

"The women took by stealth the gods of the people......For the first canoes carried no gods for human beings with them, only the gods of sweet potatoes and fish; but they brought with them prayers, incantations, and the knowledge of enchantments, kept secret in their minds, being learnt by heart, one from another."

It is not very absurd to think that these various teraphs were used for divining purposes, as a gipsy does with a pack of cards. See the various emblems on the heads of those in human form, and the strange other forms. This divining by images is one of the very old customs. I would quote that of Micah, Judges xvi., who stole the money from his mother, made teraphs for divination, and gave a wandering Levite ten shekels a year, his food and clothes, to be his priest.

Tablets.—In the Museum in William Brown Street, you may see plaster casts of two of these. The originals are made of the same hard, even-grained wood as the "Teraphs."

They are irregular in size, somewhat coarse for such expert carvers to work on. I attribute this to the great dearth of wood.

You will see the tablets are grooved into shallow channels, ¾-inch broad. In these are incised figures, or symbols, every alternate line of which is drawn upside down, for fear of confusion in deciphering them. Some of these, and very odd they are, seem capable of recognition, but must tax even a lively imagination to surmise whether they are intended as figures of existing forms, or are only technical symbols. It seems to me more picture-writing than of a hieroglyphic nature.

We do not know that more than eight of these tablets now exist. Two are at Santiago de Chile, one in San Francisco, and five in the R. C. Mission at Tahiti.

Pére Eugène, the Jesuit Padre there in 1864, says that they were then common in every house, that each symbol had its separate nickname or signification (nombre), and that though the inhabitants do not attach much importance to them, and even have forgotten their primary meaning, yet that they still copy them.

Also that, after the coming of the Missionaries, we learn they were mostly destroyed.

We did not see any in 1868.

The Chilian Captain, Gana, got but three, and says they were exceedingly rare.

Those found were at the stone houses at Terano Kau.

According to Mr. Croft, of Papaete—who sent photographs of these tablets to San Francisco — the natives of Easter Island, who are now working with the planters in

Tahiti, say that some of these tablets contain lists of lands and boundaries; some told of planting and fishing; some were about religious ceremonies and legends, and others were about the old history of the island and the former kings and chiefs.

I have taken steps to assure myself, if possible, of the truth of this explanation. Don Juan A. Bustillos (who was in the Chilian expedition) says, he was told by one of the Padres that, when one of the tablets was found, a lad who was present began to chant its contents, when an old man present stopped him forthwith. Of course, the reason for this procedure was given, that the figure-writing had reference to some religious ceremony, of which, as the *older* convert had abjured the practices, the recital was not judged by him prudent, nor politic, to be repeated.

I may mention that, though as yet no incised tablets have been found in other islands, Captain King, who was with Captain Cook in his last voyage, brought from one of the Friendly Islands a piece of tappa cloth, on which were pourtrayed representations of men, birds, fishes, articles of dress, and so on; and, besides these, some figures which had the appearance of arbitrary marks.

This cloth was divided into twenty-three compartments, in one of which, near the centre, was a rude figure, larger than the rest, having a bird standing on each hand. That on the right hand seemed to be whispering to him. This figure was surrounded by three smaller ones.*

* On the back of the image in the British Museum — Hoa-Haka-Nana-Ia — are two birds, immature, one on each shoulder-blade. Another, at the occiput, is talking to a *Rapa*, which, we were led to understand, is symbolical of *man*. I thought the two first birds were supposed to be the Apteryx, but see now they are young sea-birds. As this image is the tutelary genius of the place where the war-minister was elected in the mode described, no doubt the sculpturing bears reference to the ceremony. The meaning of the name is very doubtful, Père Gaspar told me.

In 1784, this cloth came into the possession of Mr. Thomas Astle, F.R.S., who says, "The great figure is much in the style of the Mexican hieroglyphs at Oxford."

Sculptured Stones.—To show the great fondness of these people for sculpturing, I may mention that, at the brink of the crater of Terano Kau, where the election of the minister of war was made, close to the stone houses are a great number of lava-blocks, which have been graven and carved over with faces and forms, tortoises with human faces, and so forth. They were not very plain at first, as they were overgrown with vervain bushes; and my visit was at mid-day, so that few shadows were to be seen. I sketched several, however, without knowing what I had done till the face was completed.

Maré Häia, or Stone Houses.—I did not see any, except at this same spot. I suppose there are about eighty or more of them. The walls are about 5½ feet high, and nearly as thick. The entrance is just big enough to admit a man on his hands and knees. They are lined inside with upright slabs. Over these smaller slabs are arranged, like tiles, gradually arching, till the roof is able to be formed by thin slabs about 5 feet long. I measured one of average size, 16 paces by 5 paces, and over 6 feet in height, under the centre slabs.

The passage which leads into the house is paved with slabs, under which is a blind drain, which extends about six feet outside the door. In these drains, I was told, the dead men—victims (Héaka)—were kept ready for the cannibal feast.

Most extraordinary figures were painted in red on the inner slabs, as well as sheep, a rude horse, ships with rigging, etc., monkeys with birds' heads, etc. Some seemed quite recent.

There were quantities of a small univalve, a Neritina, on the floors of these houses. In these houses the tablets were found.

Origin of Inhabitants, Migration, etc.—How and by whom was this little spot peopled? is a question which has occupied the attention of many, and to which has been attached more mystery than there seems any need for.

According to the tradition of the present race, some four hundred of them were expelled from Oparo, or Rapa-iti, another small island, about nineteen hundred miles west. They came in two large canoes, which had high forecastles and poops. The principal chief's name was Hutu, or Tuku-iu. They landed in La Pérouse Bay, which is exactly as one might expect, and stayed in that neighbourhood for some time, till Tuku-iu, some years after, went to the other end of the island. They give the names as subjoined, of the successors of Tuku-iu:—

Ynuméke.
Vakái.
Marama Róa.
Mitiáke.
Utu ìti.
Ynukúra.
Míra.
Oturága.
Ynú.
Ykú.
Ykukána.
Tucujãjá.
Tuku Ytu.
Aumoa Mána.
Tupairike.
Mata ibi.
Terakáy.
Raimo Kaky.
Gobàra.
Rô Tepito.
His son,
Gregorio, of four years old,
died in Easter Island,
1864.

Note by Philippi, p. 26:—

Tradition. Length of Ancestry.—If this seems a long pedigree, in Raratonga, Makeamakea knew his ancestors for 29 descents; in

Mangariva, the king his for 27; in Nukuhiva (Marquesas), Keatanui knew his for 88; in Sandwich Islands, Kamehameha for 67; in the Royal Family of Raiatea, not only was the name of the father, but that of the mother, preserved.

How can this be done without writing?

There was a special priest, called the Orero, whose duty it was; and as these people have an extraordinary memory, his office was often assisted.

De Bovis says, he was the living book of religion, tradition, and sacred chants: he exercised his functions before an immense crowd; but many people knew nearly as much as he did.

Annuaire de Tahiti, 1863, p. 281.

There is no doubt that the present people belong to the Polynesian race, who all agree that the cradle of their family was at the setting sun, most probably at the Samoan or Fiji group, these islands being the largest.

Note by Ernest Tinné, M.A., Oxon:—

"These Samoans are the most lovely of all the savage races I have yet seen. They have distinctly European features, and their expression is very pleasing. The tint of their skin is rich golden. The men are of great physical strength; the women are very good-looking," etc.

Sketches of Journal in New Zealand, p. 105.

The testimony of all visitors shows how great is the resemblance of the Easter Islander to this description. It would seem that, from isolation, they have not so far departed from the original type. I have not seen the Samoans, but thought that, of the Polynesians I have seen, these Islanders are most like the Marquesans.

The Polynesian has been proved to have passed over such immense tracks of ocean, that distance is no great obstacle to the subsequent arrival of migratory swarms, which has taken place, either as in the authenticated case of the New Zealander, from a desire of change, or from the overcrowding of an island, or from the involuntary cause their tradition

points to, expulsion in consequence of defeat. In 1852, we were told that, after a decisive fight between two islands, or parts of the same island, the conquerors, having surfeited themselves, put their surviving prisoners of both sexes into canoes, with a few cocoanuts, and turned them adrift.

The Malays, according to Rajah Brooke, used to be the true Vikings of the Eastern Seas, sending out fleets of war prahus, slaving and pillaging. These would be absent from home for as long as three years. How easy it would be for one of these prahus, separated by stress of weather from the fleet, and wrecked on any of these desert islands, to form by its crew and prisoners the nucleus of the population; if inhabited, to be merged into that already existing; and we find many Malay words in the Polynesian vocabulary.*

As to the size of the canoes, I dare say there is a good deal of misapprehension on this point.

The ordinary racing canoe of Tahiti holds fifty paddlers; the double war canoes of New Zealand three or four times that number; and, as a house was built on the upper deck amidships, stores and provisions were easily carried, even to serve for long trips.

I may refer, among other authorities, to the *Polynesian Mythology* of Sir George Gray, in which the size of canoes is too often mentioned to make their existence fabulous; and the circumstantial accounts of their provisioning, etc., are minutely detailed.

Before giving authenticated cases of drifting to enormous distances, let me also observe that, though the trade winds are usually contrary, there are times when the west winds, called in Tahiti "Arueroa," blow, lasting for as much as a fortnight, and accompanied by beautiful weather. Even

* In one fleet, 80 vessels were of 400 tons burden.—Marsden's *Sumatra*, p. 424.

now, the Islanders take advantage of these winds, going in perfect cockle-shells of boats to visit the easterly islands, as they feel sure the trade winds will bring them back; and the Polynesian is a most amphibious animal in case of bad weather.

Easter Island lies in the loop of a current, if I may so say, which flows from the west, and, turning round the island on the south side, goes to the north and west.

Drifting of Canoes.—Among authenticated driftings, I may quote :—

1745. People from Kamtschatka were driven to the Aleutian, some hundreds of miles.

A native of Ulea and two companions were found on one of the Radack group. They had been carried by winds, etc., to the distance of 1,500 miles.

1820. 150 inhabitants embarked from Anaa, or Chain Island, in three canoes. Two were lost; the third was found safe, 600 miles from the point of departure.

1696. 30 men, women, and children were drifted in a canoe from Ancorso to Tamar, one of the Philippines, 800 miles distant.

1821. A large canoe, full of natives, from Rurutu, one of the Pomootu group, arrived at Maurua, 500 miles in a direct course. Another from Tahiti reached an Island near Mangea, 600 miles.

The native missionaries travelling among the islands continually meet with their countrymen, who have been drifted out to sea.

1782. Captain Inglefield, of H.M.S. *Centaur*, with 11 men, went in an open boat in the Atlantic, without compass, chart, or sail, 900 miles, and landed at Fayal.

1798. Captain Bligh, with 18 men, in an open boat, 4,000 miles in 46 days.

Admiral Fitzroy says about Easter Island, *Voyages*, vol. 2, p. 558, that, until he had known of many such facts, he was puzzled to account for the discovery of other islands, and of such a speck, and how it could have been subsequently visited, but that these and other facts about birds unravel most of the mystery.

Earlier Race—Was there one?—There is no doubt that many islands now desolate were inhabited, and by a people somewhat if not altogether like these Islanders.

In Fanning's Island, midway between the Society and Sandwich groups, are to be found pavements of floors, foundations of houses, and stone entrances, as well as stone implements, identical with those which were found on other inhabited islands at the time of their discovery. The same with Pitcairns, desolate at the time of the *Bounty's* arrival. In Maldon Island, these platforms were found under the guano beds. In the Gambiers, marks of an earlier race than that now present were discovered.

From what I have seen in the Island, I am inclined to think that these various remains are not the work of a race of superior ability, now extinct, nor that the present Easter Islander has degraded from a higher type. No new comer adopts the customs of an extinct race, nor does he venerate nor preserve its relics. In all lands we see this. Here it is but lately that the statues have been overthrown; and of three which were standing in Captain Cook's time, at Winipoo, the roof of a vault has been made.

Image-making is a common Polynesian custom; but from the perishable nature of the material employed in other islands, most of them have disappeared. In the same way, where crowns of bright coloured feathers were put on the images, here caps of red tufa were substituted, from the scarcity of birds. Many images were far too recent to have been

completed for any length of time. The Island had been in a state of anarchy for fifteen years before our visit, and the upset of the social state would account for the natives ceasing to employ themselves on memorials of chiefs who no longer exercised their power as before, nor lived on their own lands. I am assured by Polynesian experts, that the time alleged to have elapsed since the arrival of this last wave of immigration suffices for the production of all the images on the island, especially if we consider the rivalry of the tribes, each of which would try to outvie the others; and there is no proof that the new comers did not find a race existing on the Island similar to, if not identical with, themselves; that they gradually fused with them, adopting their customs and practices, which would not be very different.

SOME OF THE ANCIENT JURISDICTIONS OF SOUTH BRITAIN.

By JOSEPH BOULT, F.R.I.B.A.

In his *Inquiry into the Rise and Growth of the Royal Prerogative in England*, Mr. Allen has shown that the theory of the English monarchy is utterly inconsistent with the republican habits of ancient Germany. The constitutional attributes of the English sovereign bear the stamp of autocracy, and are only paralleled by the assumptions of Eastern despots. Absolute perfection, absolute immortality, and legal ubiquity transcend the powers of ordinary humanity; yet they are embodied in the well-known constitutional dogmas that the King is not only incapable of doing wrong, but of thinking wrong; that he cannot mean to do an improper thing, and that in him there is neither folly nor weakness; he never dies; is invisible as well as immortal; and, in the eye of the law, is present at one and the same instant in every court of justice within his dominions; his legal authority is absolute and irresistible; he is the minister and substitute of Deity; all are under him, and he is under none but God. Beyond those attributes, the King possesses the whole soil of the country, and he may enter thereon at his pleasure; he is the universal lord and original proprietor of all the lands in his kingdom; and no subject can have more than the usufruct, or beneficiary enjoyment, of the land he occupies; the whole jurisdiction of the country emanates from the crown; the King is not only the chief, but the sole magistrate of the nation, all others acting by his commission and in subordination to him. Whilst in every other country, individuals are liable to suffer from violence and oppression,

in England the person injured is, in the eye of the law, the sovereign, because he is the general conservator of the public peace; and from this premiss arises the royal prerogative of pardoning offences, because it is reasonable that he who is injured shall be able to forgive. In his political capacity the King has the power of the sword; the armed force of the nation is at his sole disposal; all forces by sea and land, all castles and fortresses belong to him; and an impassable barrier environs his dominions; he is the fountain of honour and dignity, and represents the power and majesty of the whole community; he is the delegate and representative of the nation with respect to foreign powers; his acts are the nation's acts; he can make peace or war at his pleasure; and bind his subjects by the engagements he contracts, and the treaties he ratifies. The fiat of the Sovereign makes laws; his sentence condemns; his judgments give property and take it away; he is the state.

The Domes of the early Kings, collected in the *Ancient Laws and Institutes of England*, are consistent with this theory of autocracy. The first are the Domes of Æthelbirht, established in Augustine's days, in the beginning of the seventh century. The next are those of Hlothaēre and Eadric, sixty or seventy years later; they "augmented the laws which their elders had before made." The Domes which bear the name of Wihtraed appear exceptional; they are said to have been decreed by the great men with the consent of all. Ine issued his commands, after consulting his father and others, "with all my ealdermen, and the most distinguished witan, and also a large assembly of God's servants * * * on the health of our souls and the stability of our realm." Ælfred prefaces as follows:—"I, then, Ælfred, King, gathered these together, and commanded many of those to be written which our forefathers held, those which to me seemed good; and many of those

which seemed to me not good I rejected them, by the counsel of my witan, and in otherwise commanded them to be holden, for I durst not venture to set down in writing much of my own, for it was unknown to me what of it would please those who should come after us. But those things which I met with, either of the days of Ine, my kinsman, or of Offa, King of the Mercians, or of Æthelbryht, who first among the English race received baptism, those which seemed to me the rightest, those I have gathered together, and rejected the others.

"I, then, Ælfred, King of the West Saxons, showed these to all my witan, and they then said that it seemed good to them all to be holden."

It does not appear that the witan had any co-ordinate authority; they were consulted, but the responsibility and the power were the King's. It is otherwise with the pact between Ælfred and Guthrum; the witan and the people were consulted because they were sworn to them as well for themselves as for their offspring. But Edward the Elder simply commands all reeves that they judge such just Domes as they know to be most righteous and in the Dome-book stand; the witan and people are not alluded to.

Æthelstan, with the counsel of his Archbishop and Bishops, commanded his reeves, and without any reference to other counsel.

The theory on which the Domes are issued agrees with that on which the English monarchy is based, but is so irreconcilable with the Republican government of the ancient Germans, that it would be impossible to imagine how its introduction could be ascribed to the latter, except for the bias derived from the traditions preserved by Baeda and the chronicles.

The theory of the English monarchy reflects the practice of the Roman Empire; and it is reasonable to suppose that

when the Romans withdrew from Britain, those who obtained authority would imitate the rule which had subsisted here for four centuries. Assuming the power of the purple, they would meet with little opposition from those who had been accustomed to submission, and were too weak to rebel; and thus every little state which then sprang into existence adopted the same theory of government.* The growth of liberty was very gradual, and was won by servitude, when not wrested by force of arms. The very word freedom expresses service; K. *frith-domeas* (free domes); that is, the amount of fixed service to be rendered in order to secure exemption from uncertain demands.

But it may be questioned whether the theory of despotism is not incidental to every conquest. Nothing can be more despotic than the law of arms, and that is the first practically enforced; and with submission comes tribute or revenue. Therefore, though the Romans adopted the universal practice, every succeeding conquest, whether the result of internecine strife or of foreign invasion, would repeat and deepen the record. There are reasons, however, for ascribing to the Romans the lines or mould in which the record has been graven deeply, not only in the history of South Britain, but over its whole surface, and some of these will now be adduced.

As the Romans required that their conquests should be not only self-supporting, but also contributories to the Imperial revenue, taxation was of primary importance; and so the first efforts towards consolidation would be influenced by fiscal considerations; and with this purpose the territorial division into hundreds and counties is in remarkable harmony.

The revenues the Romans derived from conquered

* Allen, *ut supra*, pp. 11, *et seq.*

countries consisted chiefly of tolls, tithes, harbour duties, the tax on the use of public pastures, and the duties on the use of mines and saltworks. As soon as their power was firmly established in any part of the country, they doubtless resorted to their usage of farming those sources of revenue; and as the area of conquest was extended, their territory would be formed into divisions, and disposed of to Publicani. On the frontier, those divisions would very likely coincide with the limits of military organisation; but as the frontier was varied—and during four centuries it would be rarely stationary for any lengthened period—military exigence would disappear, and municipal regulation succeed.

The first of these, having relation to revenue, would lead the rest. The names which survive corroborate this inference. The territorial tithing, as distinguished from the numerical tithing or tenmentale, instead of being an area of ten villages, ten landowners, or ten townships; or a district contributing ten men to the armies of the conqueror; on the above hypothesis, was the area held by the farmers of *decumæ*, or tithes levied on agricultural produce, who were termed *Decumani*, just as the farmers of mines and salt were called Salinarii, &c. To secure adequate supervision, the decumani would be grouped with larger districts under some head, who may have been a public officer, or the original contractor under whom the several smaller districts had been sublet. Those larger districts represented Hundreds, Wards, Limits, Liberties, Baronies, and Wapentakes, which were sometimes combined into Lathes, Rapes, Provinces, Parts, Ridings, Divisions, Hundreds, and Wards. Numerous attempts have been made to explain the discrepancy between the term Hundred and its supposed numerical expression, but with indifferent success, whether that expression be assumed at 100 or 120. It is true the Welsh and Irish equivalent, cantref, may be resolvable into *cant-tref*, and interpreted as

a hundred farm villages;* and it is also true that the Irish Baillebitagh, or Townland, contains 120 ploughlands, but Baille-bitagh is not the equivalent for cantref or hundred; and cantref probably represents *ceann treabh*, farm limit, and applied to the area farmed to a principal contractor, and nearly synonymous with cantred, a modification of *ceann-tir-eid*, the land-tax-limit, or district. Allied to them are *airiocht*, *ceanntar*, *ceannair*, and *cortun*. Airiocht is glossed a cantred, district or canton, from *air*, of, *ioc*, rent, and *ta*, border; literally, therefore, the limit of tribute; *ceanntar*, a hundred, a cantred, a neighbourhood, and country-side, from *ceann*, limit, and *tairbhe*, profit, gain, loot, emolument, from *tair*, takes, seizes, gives, thus ceanntar, the tax limit; *ceannair*, hundred, from *ceann*, limit, and *aird*, chief, the chief district, the final *d* having been dropped, as in *air chios*, for *aird chios*, tribute, which has been further contracted into *arcis*, glossed by O'Reilly as hyde, which, in its turn, appears to be the A. S. form of K. *eid*, an aid; † *cortun*, a cantred, from *cor*, that which is used to obtain any object; also a contract; and *taun*, land, or district. The Irish Triochacead, containing 30 Baillebitaghs, is glossed by O'Reilly with cantred. Triocha is manifestly a contraction of *tir-iocadh*, the paying district, and allied to it are *iocaide*, a tenant farmer, or taxman; *iocaim*, I pay, suffer, or endure; and *iocas*, payment. The word *cead*, or *c'ed*, is an important element in the confusion which has prevailed, for it signifies both a numerical hundred and first. When originally used it may have denoted the first or principal district; and the mistake may have arisen when some of the tax-collecting districts, having become more populous, contained about a hundred of ploughlands, villages, hides, freemen, or whatever the unit might be which in the aggregate was supposed to have formed the hundred.

* Cantrevydd, however, would be the correct plural form; and so cantref is probably *ceann treabh*, as suggested above, or *cean treabh*, the chief farm.

† "*The Hide of Land*," *Trans. Hist. Soc. Lan. and Chesh.*, 1872–3.

The supposition that a tithing consisted of ten farms or families, and the hundred of ten tithings, implies arrangement much too symmetrical for the hostile occupation of a country; such symmetry may, and to some extent does, exist in the United States and in Australia, where new countries, almost wholly unoccupied, have been colonised by peaceable settlers; emigrants from nations in the highest state of civilisation; even in those countries the symmetry may appear as a plan on paper, but cannot be reduced to practice until a certain minimum of settlers is secured.

But for those who enter the country with arms in their hands, whose advance is contested step by step, who are constantly exposed to attack and surprise, and whose frontier assumes an irregular outline due to the comparative strength or weakness of the foe, the difficulties of such arithmetical symmetry must be insurmountable; whether it be assumed that the sub-divisions were made by the Romans, or subsequently, the supposition is alike untenable. At what interval, it may be asked, between the departure of the Romans and the arrival of the Normans could such adjustment be accomplished? What Sovereign was there who possessed the influence and enjoyed the pacific rule which permitted all the details to be worked out? If these questions be frankly considered, it can scarcely fail to be apparent that such a scheme could not be developed amid the internecine strife so perpetually waged in those centuries. Nor does the realisation appear more feasible if it be ascribed to the Romans; for it was not by one victorious effort, but by numerous successes, extending over nearly the whole period of their stay, that they obtained the supremacy, of which such important results still survive. It seems much more consistent with the teachings of historical experience to suppose that the Romans, as they subjugated each tribe or division of the country, made it tributary, and as their

position became secured, removed the native chieftain, or subsidized him, just as they found him untrustworthy, and were desirious of having his territory in their own hands, or found him friendly, and suiting their purpose as well as any other representative. The history of British rule in India is, doubtless, in several respects, a pretty faithful reflex of the Roman sway in Britain; and of all other conquests of a weak, divided, and uncivilised people by one strong, and possessing all the advantages which the highest culture affords. Then, as such conquests are always prompted by greed—the lust for acquisition—the first object after security would be tribute, and the leading man in the district would be the chief collector, perhaps as a farmer, or, in modern phrase, contractor, undertaking to produce a certain return and at liberty to extract as much more as he can. With pacification, consequent upon increased security, the Romans would naturally introduce the mode of collection to which they were accustomed; and sooner or later, the publicani, or their system, would be introduced.

What, then, were Tithings, and what Hundreds? The *primâ facie* meaning of tithing, as applied to a tract of country, is a district within which tithes are levied and collected. In this period persons are familiar with ecclesiastical tithes only; and the tithing district and the parish are for the most part, if not always, coextensive, and popularly identical. But it would be different when tithes were called tenths, or took the form of fifteenths, and were levied for secular purposes in a country only partially inhabited under a permanent government; a country in which the settlements were separated from each other by forest or waste; the haunt of outlaws or of those who spurned the authority which claimed to govern the country. In such circumstances, tithes might represent districts within which *decumæ*, or tenths, were collected by Roman authority. As the outlaws

were subdued, or expelled, the land they occupied would be added to the tithings already formed, or would be constituted one or more additional tithing, as expedient.

The Welsh for tithing, deg-tyddyn, literally a ten-farm, that is, a farm of ten, is generally confirmatory of the above conjectures. Deg-tyddyn cannot mean ten farms, as tyddyn is the singular form of the noun.

The tithing-man is described as being now a kind of petty constable, elected by parishes (observe the sign of identity); there are some things a constable has power to do which tithing-men and headboroughs cannot intermeddle with; but when there is no constable in a parish, the office and authority of a tithing-man seem to be all one, under another name. According to Coke, constables were created 18 Edw. I., and their duty thereby limited.* With the assimilation of parish and tithing, the endowment of parishes with *decumæ* may have been coincident, such endowment indicating that one of the original functions of the landholder, that of a publicanus, had become effete; no longer paying over as rent a proportion of the tenths collected, he paid aids or hides, subsidies, tállages, etc., and retained the whole of the *decumæ* as such. Then the clergy, taking advantage of the resemblance between the Roman *decumæ* and the Hebrew tithes, enforced alleged Scriptural rights to the tenths; and so the landowner endowed the parish he formed with the tithes he possessed; and thus the outlying portions of his territory became annexed to a parish from which they were geographically separate, and the priest, or his proctor, assumed the functions of tithing-man, so far as they included the assessment and collection of tithes.

The district tithings appear to have been confused with the decennary provisions which subsisted for about a hundred

* Jacob's *Law Dict.* in verb.

years from Æthelstane to Edward the Confessor, which seem to have been originally instituted under *Judicia civitatis Londoniæ*, to have been adopted in York under the term Ten mentale, and to have been ultimately lost, with the borh, in trade guilds and municipal institutions as now known.

The word parish supplies another indication of the abiding influence in Britain of the Keltic race and speech. Though the word is ordinarily ascribed to the Greek *paroichia*, it is difficult to perceive resemblance between the functions indicated by the two words. The Greek denotes merely a dwelling in a place, a sojourning, whilst the K. *parraiste* or *porroaisde*, pronounced paraishte and porroaishde, denotes, literally, God's plantingway or path, which accords pretty closely with the ideal of a parish as originally designed.* The compound, *parraisteach*, or *porroaisdeach*, parishioner, is a regular derivative, and allied is *paraitsi*, a bishop or parish priest, the office of early bishops in these islands. It may be readily imagined how, when knowledge of the Keltic language had been lost, not only would the final *de* be dropped, and so the word become porroaish, or parish, but also how, in Low Latin, the word became *parochia*, and thence referred, by learned yet ignorant clerks, to the Greek, just as the name of Eccles and its compounds have been referred to the Greek *ecclesia*, instead of the K. *eaglais*.

As secular tithings were grouped under a supervisor, or superior contractor, those groups would receive appropriate designations, and hence the Hundreds, Wards, Liberties, Baronies, and Wapentakes of the various counties or shires, which again were grouped into larger divisions. Some of the latter terms denote simple arrangements, as Provinces, Lathes (K. *leith* or *leath*, a half, a side, a piece), and Divisions. Baronies or Lordships seem to indicate per-

* Another Keltic word for parish is *bebra*, the preaching district.

sonal supremacy, as Liberties or Sokes popular control, by socemanni or freeholders; whilst Rapes, Wapentakes, and Hundreds are evidence of tribute only; Wards, of protection, consistently with which they appear in the Border counties of Cumberland and Westmoreland, and as terminals in the names of places on the Welsh border, such as Lentwardine, Hawarden, and many others; as divisions of cities and towns, each with its ealdorman or captain of the guard; and the word is also applied, for a like reason, to those combinations of divisions which give security to a lock.

Rape is apparently from Teut. *ræp* or *rap*, equivalent to K. *rop*, a rope, of which the form *ræp* survives in the English *reap*, the operation of binding the stalks of cut corn into sheaves with ropes of straw, and hence applied figuratively to the binding together of tithings for the reaping of tribute.

The word Wapentake, on the authority of the *Laws of Edward the Confessor*, is usually referred to the array of arms, in which the weapons are said to have been clashed together; Teut. *Wæpn-tacan*. But the MSS. relied upon for those laws, as now extant, are of the 13th and 14th centuries, and are supposed to embody the explanation of some anonymous scribe, who appears to have confused the Wapentake with the Wapenschaw, or weapon-show, which was a periodical muster of the men of a district, capable of bearing arms, who produced their weapons for inspection; an institution which was probably disused when the militia was organised, and of which Scott gives an amusing illustration in *Old Mortality*, when Guse Gibbie completes the muster of the Lady of Tillietudlem.

If I do not err in ascribing the territorial divisions of the country to fiscal rather than to tribal affinity or military convenience, the word Wapentake is resolvable into K. *ua-pian-tac*, literally the lease-afflicted district, which might aptly indicate the condition of those who were handed over

to a merciless *comes*, or contractor. The word *tac* survives in Scotland in the sense of lease, or possession for a definite time, the tacksman being primarily the person who holds the lease, subsequently the steward, or other representative of the lord. To the same root we owe the word tax, payment for revenue, which appears as tasks in *Confirmatio Chartarum*;* also tacks for small nails, and probably take, through the Teut. *tacan*, which looks as if it were the Keltic noun converted into a verb, in Scotland still pronounced tak, as in the old song:—

"Tak thine old cloke aboot thee!"

The name of Wapping, London, is allied to the word Wapentake. It was formerly a great wash, covered by the waters of the Thames; afterwards, being partially regained from the river, and becoming marsh, it was the usual place for hanging pirates and sea-rovers, at low-water, there to remain until three tides had overflowed them;† K. *ua-pian*, place of punishment.

The word Wappened, now disused, and hitherto a puzzle to commentators, is ascribable to the same root, as signifying worn and afflicted with sorrows, as after severe punishment. The cynical Timon of Athens says of gold:—

"This is it
That makes the *wappened* widow wed again."—iv. 3.

So also, assuming wappered to be a misprint for wappened, the latter is used by Beaumont and Fletcher, in their *Two Noble Kinsmen*, v. 4:—

"We come towards the gods
Young and *unwappered*, not halting under crimes."

* 25 Edward I., c. 5:—"And for so much as divers people of our realm are in fear that the aids and *tasks* which they have given to us beforetime," etc.

† Stowe's *London*.

And in the *Mirrour for Magistrates*, 1575:—

> "But still he stode his face to set awrye,
> And *wappening* turned up his white of eye."

Possibly the verb, to weep, is a modified derivation from the same root, supplanting the original word. Weped or *wappened*, according to Warburton, signifies both sorrowful and terrified.

The word survives in its original sense of punishment when the Lancashire mother tells her unruly child, "I'se gie tha a wopping;" and whopping, in the sense of big, may be assigned to the same root.

The growth of the several forms may have been somewhat as follows:—

1. From *ua-pian*, the place of punishment, or the district of pain, becoming wapen, the word pain itself being manifestly a corruption of pian.

2. From wapen, the first part of the word wapentake, and the adjective wapened.

3. By a corruption, very common, of adding *g* final after the letter *n*, comes Wapping, as the place of punishment for the greatest criminals.

4. The punishment for great crimes being inflicted at Wapping, a person guilty of great crime would be said to deserve a Wapping punishment, that is, such a punishment as was inflicted at Wapping, and thus whopping would become interchangeable with great.

5. In like manner, the severe punishment of a child would be called a wopping.

Since the above was written, correspondence has appeared in the *Athenæum*, on the passage from *Timon of Athens*, in which Mr. Skeat suggests that the expression *wop-eyed* means *weep-eyed*, basing his suggestion upon a passage

in the *Ayenbite of Inwyt*:—"There is *wop* and grindinge of teth;" and on the word *wopig* in A. S. poem of *Juliana*, thus confirming the conjecture given above, that the verb to weep is from the same root as wapentake.

The Welsh rendering for wapentake is cwmwd; but cwmwd does not always represent a wapentake, and it seems probable that the gloss is entirely erroneous. In the collections of the Powys-land Club are the following descriptions of Montgomeryshire:—"Cantref Cynan, C. Cyfeiliawg, C. Mawddwy, O. L. H. Y. Ac velly y cad yn y Dalaeth hon xiv. Cantrev; ac yn y cantrevydd hynny i mae xl. cwmwd [and so in this province are found fourteen cantrevs, and in these cantrevs there are forty commots].*

Further, the ancient Commots of Powys were six in number, viz., Caerinion, Llanerchydol, Ystrad Marchell, Mechan Iscoed, Mechan Uchcoed, and Mochnant, which became six manors when submission was made to English rule.†

According to Sir Richard C. Hoare, the hundreds and comots of all Wales were divided in the time of Llywelyn ab Grufydd, the last Prince of the Welsh, who was killed in 1284. He says:—"Wales consisted of three provinces: one depending on Aberfraw, in Môn; the second on Dinevwr, in the south; and the third on Mathraval, in Powys."

Of these, Aberfraw contained fifteen hundreds and thirty-eight comots; Mathraval, fourteen hundreds and forty comots; and Dinvwer, twenty-five hundreds and seventy-eight comots, making in the whole fifty-four cantreds or

* The Territorial Divisions of Montgomeryshire, compiled by Morris Charles Jones, in *Collections, Historical and Archæological, relative to Montgomeryshire*, issued by the Powys-land Club, Part iv., April, 1869, p. 72.

† *Ibid.*, 108. Montgomery was constituted a shire, 27 Henry VIII. (1535), c. 26. *Ibid.*, 125.

hundreds, and thus agreeing with the number stated by Giraldus Cambrensis.*

Some of the hundreds contained only two comots, some three, some four, and some five.

The words cwmwd, commot, conmot, and comot appear to be synonyms with ge-mot; in fact, those words are merely dialectal variations. Merewether and Stephens, referring to the legislation of Henry VIII., say that the commotes and cantreds of Wales are analogous to English Boroughmotes and Hundreds.†

Daines Barrington, on the authority of Giraldus Cambrensis, assumes that commote signifies in Wales a portion of land equal to the fourth part of a cantred.‡

It is possible that in some hundreds the difficulties of transit rendered it desirable to have four ge-mots in each; but it seems more likely that instead of, or in addition to, the township and hundred moots, there were moots of intermediate importance.

On reference to the preceding description of Montgomeryshire, it will be seen that the commotes in that county averaged nearly three to each cantrev.

Allied to the moots were the *cymorthau*, forbidden by Statute 4, Henry IV., which appear then to have been assemblies of the discontented to concert resistance to the authority of the English king; allied to W. *cymorth*, help or assistance.§ Possibly, they appeared to the Welsh a revival of their ancient moots or things.

In the word Hundred appears another confusion of terms resembling that of *triocha-cead*, explained above. If the original for hundred was K. *an-tir-eid*, the tax, or aid district, the confusion by foreigners with hundrede was very natural,

* *The Itinerary of Archbishop Baldwin through Wales*, 1188, ii. 263 - 71.
† *History of Boroughs and Municipal Corporations*, 1148.
‡ *Observations on the more Ancient Statutes*, 125 note. § *Ibid.*, p. 360.

especially if the number of units exceeded that number. A similar confusion appears to have arisen between K. *cir*, joined, united, and Teut. *scir*, a share, a district. No doubt the Keltic *c* is hard, but there are numerous examples in which it has been softened by some of the foreign influence of which there has been so much; for instance, in *cyrc*, kirk or church. The principal reason for suggesting this different etymology for the word shire arises from the fact that the process of conquest and consolidation is one of accretion, not of separation; therefore, that decennæ, or tithings, would be annexed to each other to form hundreds, which in their turn would be united to form shires, seems but probable.

That such was the actual process, is confirmed by the fact that many hundreds were formerly called shires, that is, unions, as Hallamshire, Hexhamshire, Craigtonshire, Westderbyshire, and others. As they sank from their original importance, and became subordinate to some greater magnate, they lost the appellation of shires and became hundreds only.

Prior to 10 Henry III., Westderbyshire consisted of three hundreds — Derby, Newton, and Warrington — and thence, probably, the appellation of shire. When absorbed into the county of Lancaster, and the hundreds of Newton and Warrington were completely amalgamated with that of Derby, the latter name was given to the union, a change which shows that the word hundred did not then mean that number of units, or else the three hundreds must have lost some two-thirds of their component parts. As respects the hundreds of Salford and West Derby, they were termed Wapentakes as recently as about 1588,* a fact which seems to indicate that the words hundred and wapentake are inter-

* Baines's *Lancashire*, i., 179.

changeable, and not restricted to any locality, wapentake probably being expressive of severity of taxation imposed on the unruly.

It is remarkable that in the Lancashire, as in many other parts of *Domesday*, the words manor and hundred are nearly interchangeable, as we have seen they were in Montgomeryshire. Of Newton hundred it is said, "The other land of this manor 15 men called Drenghes held for 15 manors; to the manor of Warrington belonged 34 Drenghes, who had that number of manors. The whole manor with the hundred rendered to the king a farm-rent. To the hundred or manor of Blackburn (*ad hoc manerium vel hundredum*) were attached 28 freemen, holding land for 28 manors; to the manor or hundred of Salford belonged 21 berewicks, which as many Thanes held for as many manors; the whole manor of Salford with the hundred rendered, etc.; to the manor of Leyland belonged 12 carucates, which 12 freemen held as so many manors; the men of this manor and Salford were not bound by the custom," etc.*

The expression used twice, in Warrington and Salford, "the manor with the hundred," seems to imply a distinction, which, I suggest, has reference to the geld or aids payable by the hundred, distinguished from the manorial rights, over so much of the land as had not been granted as manors.

The Ridings of York and Lincoln, as of Cork and Waterford, appear to be contractions of K. *tir-eid-ting*, representing subordinate "things" or moots, for those who were prevented, by the impassable state of the county, from being able to discharge their custom at a central shire moot. The Keltic name would readily assume the form of

* Beamont's *Extension*.

of T' riding, which in time would be supposed to represent "the riding."

That hundreds were a fiscal as well as territorial division, appears probable from the fact that cities and important boroughs were generally rated as hundreds, or parts of hundreds; for example, Cambridge as a hundred, Chester and Bedford each as half a hundred.

On the assumption that the Kelts never were exterminated, but have persistently remained the bone and sinew of the English people, it is conceivable that not only have Keltic words and phrases been so altered as to be recognisable with difficulty, but that words from other languages, more familiar to immigrants, conquerors, and their scribes, have been erroneously substituted, especially where the sound and significance of the substitution resembled those of the original.

Thus, as suggested above, the numerical *hundred* was substituted for the territorial *antireid*, for the latter spoken fluently would resemble the former, if the letter *t* be replaced by *d*.

The title of Comes presents apparently another example. When hundreds were accreted into shires, the person to whom the revenue of the shire was intrusted, whether contractor, ardrigh, or regulus, would be known to the populace by some vernacular epithet, expressing pithily the popular idea of his most conspicuous function.

Now, to all intents and purposes, the exaction of tribute being the primary object of invaders, the most conspicuous function of such an official would be the collection of tribute from the district confided to him; and his first duty would be to assess each part, and perhaps each landholder, for the proportion to be contributed by each. The Keltic word which most nearly expresses this duty, and most nearly resembles

the Latin *comes* in sound, is *comas*, now rendered power, warrant, leave, and faculty. It is, however, resolvable into *co-meas*, united assessment. When the word *comes* was lost in count and earl, and the assessment and collection of aids or hides passed to other officials, the special significance of the word might be lost, and those récited above acquired instead, they being adjuncts of *comeas*. The derivatives accord with this conjecture, as *comasdair*, a commissary, and *comasdairachd*, commissariat, for not only was tribute-rent paid to the chief, in cattle and food of various kinds, but the Romans received much of their taxation in cattle, grain, hides, and other articles of consumption. The final part of the words cited involves the idea of cattle, being allied to *dart*, a herd; *dartach*, a two-year old bull; *dartan*, a herd, a drove; *dairt*, a heifer, and others; and, for the purpose of profitable conversion, the tribute in cattle would pass to the commissariat. It is difficult not to suppose that the words commissary and commissariat are derived from the Erse. Webster refers them respectively to the French *commissaire* and the Spanish *comisariato*; but all the three languages are Keltic, and have doubtless obtained the words from a common root.

It is noteworthy that in Erse, *contath* (cōnta) denotes a country; apparently it is resolvable into *con-tath*, in which *con-* is the copulative prefix, and *tath* means ruler, and also cement; therefore, the compound indicates that the district is an aggregation, either under one ruler, or simply in union.

The Earldom of Arundel appears to retain traces of its original institution; it is still a territorial fief, title and estate, including castle, indissolubly connected, and by Act of Parliament attached in perpetuity to the Dukedom of Norfolk.* The Earldom of Mar, in Scotland, boasts an

* Burke's *Dormant and Extinct Peerage*—in nomine De Albini.

origin so ancient as to be lost to history; but in this case the title only survives, without any territorial possession.

The French word *comte*, which has superseded *comes*, was formerly spelt *compte*, and the English equivalents for those words, in their separate significance — count and account — are indicative of fiscal origin. In English usage, the title of count has been superseded by earl, K. *airle*, counsel; but an earl's wife, or a lady of earl's rank in her own right, is still styled countess; and the title of viscount perpetuates the earl's deputy, or vice-comes.

The reasons of the change from count to earl are obvious. The *comeas* would be acquainted with, or would possess the means of learning the state of his shire; the feelings of the inhabitants, if they were well or ill-affected, and other matters which would give value to his counsel; and he would accordingly be consulted as occasion arose. As the position of a trusted adviser was more honourable than that of tax-assessor, the latter title would be merged in the former.

Though the title *comes* does not appear in the *Ancient Laws and Institutes* before the time of The Confessor, whilst that of earl recurs frequently from the time of Æthelbirht, it must not be supposed that the former had fallen into oblivion, as it is frequently used by Bæde, and rendered by King Ælfred, in his version of that author, by *gesith*. From some inexplicable cause, it has been supposed that the word *gesith* and its compounds were applied to the military companions or followers of the A. S. chiefs and kings; and Thorpe asserts that this is the true meaning of the word, as used in many passages of King Ælfred's translation of Bæde, naming Books iii., 14, 22; iv., 4, 10, 22; and v., 4, 5. But those are the passages in which *gesith* is given as equivalent to *comes*, and it has yet to be shown that even in Latin that word refers to military companionship only.

Thorpe supposes the term *gesith* to have been superseded by *thegn*, and that the *gesith* were the same with the *Leudes* of the Franks and the Visigoths, and both derived from the *comites* of the ancient Germans; but it is to be observed that *thegn* is used by Ælfred, as distinct from *gesith* or *comes*, and to interpret *miles* (Book iii., 14).

It is remarkable that the use of the term '*sithcund*,' as used in the 10th *Wergild*, equivalent to '*ceorl*,' in the *North People's Law*, should have been overlooked. As translated by Thorpe, the words are as follows:—That however a *ceorl* might thrive, "if he have not that land, he is '*sithcund*,'" that is, himself only. If, however, his son, and his son's son, have the land, "let their successors be of the '*sithcund*' kin."

I apprehend, however, that as it is pretty clear the latest social strata in these islands have drifted from the East, traces of older formations must be found Westward; that, if the secrets of the past are to be disclosed, they will not be obtained from the coming man, but from him who is gone before.

If Mr. Thorpe, instead of ranging the Continent, had referred to an Irish dictionary, he would have found the following words, which appear to be closely allied to *gesith*, namely, *sith* or *sioth*, peace, quietness, concord; *siothach*, peaceable; *siothadh*, peace-making; *siothadair*, a peace-maker; *siothlaethe*, days of peace; *siothlodh*, making of peace; *siothmhaor*, a herald, constable, or peace-officer; *sithbreitheamh*, a justice of the peace; *sithbhreisteach*, a disturber of the peace, also riotous, disorderly; *sithim*, I pacify. There will also be found the word *cond*, keeping, protection. *Sith cond*, or *sith cund*, therefore, signifies peace-keeping, or peace-protection. To this day a disorderly person is frequently bound over to keep the peace, that is, to become *gesithcund*.

From the same root, *sith,* is derivable the word city, that is *sigh-tigh,* as containing the peace-house or minster in which a bishop officiated, or of equal rank, and to which, therefore, a right of sanctuary was attached, as appears from several domes, under the terms *church-grith, i.e.,* church knowledge. O'Reilly gives *sith-bhe* (see-ve), as denoting a city; *seithbheach* (seevach) civil, of a city; which, with some words cited above, seem to confirm this conjecture, as more consonant with usage than that civic terms are from the Latin *civitas.* It may be thought more probable that *civitas* and *civilis,* with *sithbhe* and *sithbheach,* in some way spring from a common root.

The word citizen may be referred to *sitbhe-eis-in,* denoting a fit city man, one of the *potentes,* and allied to denizen, *dinn-eis-in,* a fit fortman, the Welsh being respectively *dinasydd* and *dinaswr.* So the dozein or dozeiners of whom mention is made in old ordinances were *do-eis-in,* of fit men; when or why the word dozen came to signify twelve is as uncertain as the number of a petty jury, to which the dozein appear to have been allied.

The first mention of an earl in the Domes is in the 13th of Æthelbirht's, specifying the bot to be paid for killing a man in an earl's tun, which was twelve shillings, as against fifty for the like offence in a king's tun.

The first of the Domes of Hlothære and Eadric prescribes that if an esne slay an eorlcund man,* whoever it be, the owner shall pay 300 shillings; but there does not appear any direct clue to the functions of an eorl prior to the 12th of the Domes of Edward and Guthrum, which provides that, if an ecclesiastic or foreigner be wronged through any means, then shall the king, or the eorl there in the land, and the bishop of the people, be unto him in the place of

* That is, a man entitled to the protection accorded to an eorl.

a kinsman and of a protector, unless he have another. Here the eorl appears as the king's representative or substitute. In the first of the Domes as to *Ranks and Laws*, the eorl is named with the ceorl, thegen and theoden, as among those from whom the counsellors of the nation were selected; but the expression is not precise, and it is possible that an eorl was counsellor quâ eorl, like a modern peer of the realm, whilst the other ranks furnished counsellors by election.

It is, however, clear that the counsellors were supplied by those four grades, and by them only, except the ecclesiastics, and those grades, I apprehend, were represented by people who were termed, at different periods, and on different occasions, gesithcund, law-worthy, lawriht, *legales homines*, good men and true, the *posse comitatus*, and the like; whilst the counsellors in council assembled were the leod, and the different kinds of council gemot or conmot, as the witenagemot, the scir-gemot, and others.

The functions of an eorl, like those of the comeas, then, seem to have been anything but military, except in so far as might be requisite for the maintenance of peace, or the recovery of lawful taxation, and the *posse comitatus* to be a force purely civilian in its constitution and purpose, though perhaps not quite so civil in action.

The fiscal character of ancient earldoms is illustrated by the manner in which possession was confirmed. In many cases we read, as in that of William de Albini, temp. Henry II., who obtained confirmation of the Earldom of Sussex, of which county he was really earl, by a grant of the *Tertium denarium* of the pleas of that shire, popularly known as the third penny of the county.

Thorpe says that the etymon of the word eorl is unknown, though he classes it with jarl, comes, satelles, principis. He says, the title seems to have been introduced

by the Jutes of Kent, but its general use dates from the later Scandinavian invasions.

The word *jarl* closely resembles, in sound and appearance, K. *iarla*, which is itself a phonetic contraction of K. *iarfhlath*, signifying one next to the prince, a feudatory lord, one depending on a greater. Iarfhlath is compounded of K. *iar*, after, and *flaith*, a lord. In composition the letter *f* is aspirated, and so rendered mute. Possibly, the word *airle*, signifying counsel, may be derived from the practice of taking counsel with men of that rank. The suggestion that the *jarls* or *comes* were companions of the sovereign, even when presiding over distant provinces, was a somewhat gross attempt to render an unpopular title agreeable to the wearer; and to this fiction may be attributed the style whereby the king addresses an earl as *dearly beloved cousin.*

The terms lawriht and law-worth are, I apprehend, almost, if not quite, identical; for, in Anglo-Saxon, worth and wright are the same; and the term wright was applied to any man of worth in his craft, that is, to all skilled workmen worthy of being employed in the construction of ships, ploughs, mills, wheels, etc.

Another remarkable illustration of the respect in which skilled labour was held is afforded by the Keltic word *saor*, which is the equivalent of wright, and also signifies, as an adjective, free, noble, voluntary, as though a man was servile until he had acquired skill in his craft, that is, until he had completed his apprenticeship.

One of the principal objects of social union is the maintenance of order, that is, law; and the Domes teem with various devices for attaining that object. The *hlaford*, or lord, of whom there is such frequent mention, was so called from K. *lamh-ord* (lavord), the order-surety or guarantee. The Irish for lord, *tiarna* represents *ti-arnaidhe*, government security.

When the sound of *u* was substituted for that of *v* or *f*, lamhord became lauord, which would easily glide into its present form, lord.

So the leod is K. *li-adh*, law-fit; *adh* really means fit for anything, and *li-adh* would appear to signify that those so termed were fit for making and enforcing law. If any of the leod were obstructed in their attendance on the king, a heavy penalty was incurred. The second of Æthelbirht's Domes prescribes that, if the king calls his leod to him, and anyone there do them evil [let him compensate with] a twofold bot and fifty shillings to the king. So it may be inferred that a lawriht man was entitled to, or worthy of, the protection that secured order, and was also worthy of enforcing it.

Perhaps the prototype of the lord is to be found in *defensor civitatis* of the Roman law, whose duties were somewhat more onerous than to cut the loaf in his household.

The lord's wife, or hlafdia, was then, as now, his idol, or domestic goddess, K. *laimhdia*, which has almost the same sound.

By some of the Domes, *every* man, not the members of any particular classes, must be attached to some lord, that is, to some surety for the maintenance of order; under others, to some *borh*.

But, from the Domes, it is clear that the maintenance of the king's peace was a part of the ealdorman's duty, at any rate since the time of Ine, 36th of whose Domes enacts, that if anyone allows an arrested thief to escape, he shall pay for the thief according to his *wer*, but an ealdorman so offending shall forfeit his shire, unless the king is willing to be merciful to him. The 6th of the Domes contains the first mention of the officer which occurs in those documents, providing, that if anyone fight in an ealdorman's house, or

in that of any other distinguished *wita*, the bot should be 60 shillings, with a second 60 shillings as *wite*. For a like offence in a minster, the bot was 120 shillings; but in the house of a gafol-gelda, or gebur, the wite was 12 shillings, and the gebur received 6 shillings more.

In 3rd and 16th of Ælfred's Domes, a bishop and an ealdorman appear of co-ordinate rank, as the bot for borh-bryce, or fighting, in the presence of either is the same. In 38th of the Domes, a king's ealdorman apparently represents majesty in the gemot and in the folk-mot. If a man fight in the ealdorman's presence in the former, he is to make bot with wer and wite as it may be right, and before this pay 120 shillings to the ealdorman as his wite. If he disturb the folk-mot by drawing his weapon, 120 shillings to the ealdorman as wite.

In the *North People's Law*, the wer-gild of bishop and ealdorman was identical.

In 6th Article between Æthelred and the Danish army, the ealdorman is charged to go in pursuit of murderers in cases of frith-breach, should the inhabitants neglect to do so; if he failed, the duty devolved on the king, or the ealdordom lay in unfrith.

In the Domes 8 and 10 of Eadgar, the term 'ealdor' of the hundred only is used, whilst the term church-ealdor appears in 5th of Ælfred's Domes, on Church-frith, that officer being required to prevent fugitives from receiving food. Should the church be required by the brethren, they may remove the fugitives to another house, but that house must not have more doors than the church. I apprehend that the ealdor of the church was the ostiarius, or church doorkeeper (circean-dure-werd) of the Canons of Ælfric (11); the doorkeeper who holds the keys of the church (duru-weard sethe circan caegan healt) of his Pastoral Epistle (34); and, therefore, that the word ealdor is from K. *il* or *all-dor*, signifying

great door or gate, surviving to the present day, to indicate the great or principal door of a house, as the Hall is the principal house of a town or village.

The word ealdorman was probably applied, in the first instance, to burhs of importance, to indicate the chief man of the guard at the principal gate, K. *all-dor-meann*, for it may be observed that the doorkeeper of a church was not styled ealdorman, but simply ealdor, from which it may be inferred that the terminal -man, in this as in other words, is a corruption of K. *meann*, great, allied to the French *magne*, and the Latin *magnus*.

The aldermen of wards in boroughs doubtless discharged at some time military or quasi-military functions, from the arrest of petty disturbers of the peace, to the suppression of rebels in arms. The term Ward is very suggestive of such a purpose, and of the transition from the king's ealdorman of hundreds, through train-band captains, like Johnny Gilpin, to the present eminent civic dignitaries, who are colloquially more portly than wise.

In the official style of the Lord-Lieutenant of Lancashire, he is described as Vice-Admiral of the County Palatine. That function the officer may have discharged at some former period; and it is very probable that every officer of the king was liable to discharge a variety of functions, according to his personal qualifications, his interest at Court, or the exigency of the time. So late as the reigns of William and Mary, and of Anne, the marked separation now maintained between the Army and Navy was unknown.

The Keltic word *all*, signifying, in the various orthographic forms of *il*, *ol*, *oll*, and *ull*, great, big, much, all, and universal, appears to survive in many forms, including the names of places. In South-west Shropshire, for example of the latter, are *All*-Stretton, that is *Great* Stretton, and Little Stretton, both on an ancient line of road, from which

the common designation is derived. They are upwards of three miles apart. About midway is Church Stretton, now the most important place of the three, but originally, perhaps, containing only the church and presbytery, as convenient for the cure of All-Stretton and Little Stretton. Subsequently the market was also established there, the combination offering irresistible attractions to settlers.

A curious illustration of the use of the word *all* appears in ale-house, the house for all, at which every wayfarer was entitled to go, analogous to the modern term, public-house. When its original meaning in that connection was lost, and its pronunciation modified into *eal* or *ale*, it was supposed that the house derived its title from the beverage supplied to all, when tea, coffee, and other temperance liquors were unknown, and so beer acquired its pseudonyme of ale. Various possessions were held by the tenure of providing good entertainment for man and beast.

Another example of the use of *all* appears in *Ivanhoe*. When the Knight of the Fetterlock attended the obsequies of Athelstane in Coningsburgh Castle, Cedric greeted him with *Waashael* (above all!), raising at the same time a goblet to his head. The King, no stranger, we are told, to the custom of his English subjects, returned the greeting with the appropriate words, *Drinc hael* (drink all!), and partook of a cup which was handed to him by the sewer. From the words used by Cedric may have come the name of the Wassail-bowl; and from *all*, in its various forms, the interjection hail! the adjectives hale and healthy (*all-ti*), and the noun health; also, whole and wholesome.

This idea of guard or keeper seems to underlie such designations as freeholder, leaseholder and staatholder. It is impossible to ascribe to the latter title of a representative of popular government the idea of possession which in the present day is associated with the two former terms.

The staatholder's function was to guard or keep the interests of his constituents. So the freeholder, *i. e.*, K. *frith-ealdor*, was required to guard and keep his frith or service in town or country; and the leaseholder, K. *leas-ealdor*, was to guard and keep his leas, *i.e.*, the property confided to him on terms intended to serve the profit or advantage of both parties, K. *leas* signifying duty, profit, interest, or advantage, whilst *léas* signifies reason, motive, or cause. The derivative from the latter, *léasachadh*, is suggestive, as it denotes correcting, amending, repairing, or manuring, the terminal *achadh* signifying a field, or representing *acaidh*, an abode or habitation, *acaideadh* being a tenant, an inhabitant.

The headborough was called also borsholder and burhealdor; the householder, or husband, was responsible for the *family*, and generally the word *holder* indicates a trust, or *quasi* trust, distinct from the absolute possessive meaning attached to the word *owner*, thus preserving traces of its original designation for a doorkeeper, like the church ealdor.

From the form *holder* come, apparently, the verb to hold, the nouns hold and stronghold, and the participle holding; while the past form, held, is merely an orthographical variation, the appropriation of the two forms to different tenses, being probably arbitrary and conventional.

The title of Thane, like those of Earl, Count, and Ealdormann, is ambiguous, arising probably from the error of supposing that, in the interval between the Romans and the Normans, all institutions and titles were subject to but little modification. Such a supposition is manifestly unreasonable, as will appear if comparison be made with any other period of six centuries. Institutions are subject to the changes incident to growth and decline, and those must be perplexing in the absence of precise information throughout the whole period.

To assume that the king's thane of Wihtred's Domes was identical with the thane of Henry I. would be as unreasonable as to assert that Shakespere's Thane of Cawdor, who lived a prosperous gentleman, represented the real Macbeth, or that Cedric of Rotherwood was a type of all the thanes who ever lived.

The word thane, as a title, appears to have acquired a technical significance, represented by the conversion of K. *tan* (thaun), a landowner, into K. *tanaise* (thaunaishe), second, indicating that the person so designated held secondary rank. Probably it was applied originally to the eldest son, who would rank first of the king's thanes, and so be *the* thane, just as the king's wife was first of all his women, and so termed *the* queen. As the title of queen became applicable not only to female sovereigns, but to other chief women, as the Queen of Heaven, the Queen of Beauty, the Queen of May, and others, so the title of thane would be conferred on those who held position next to the highest, like that of a king's thane, who, within his jurisdiction, was next after the king.

It is manifest such a term might be applied very indefinitely to all persons of secondary rank, though probably the possession of land was originally essential. It was prescribed that, however a ceorl might thrive, though he had a helm and coat of mail, and a sword ornamented with gold, yet had not the land yielding five aids for the king's outwar, he was nevertheless a ceorl.* This condition, however, was waived in favour of the mass-priest, and of the merchant who had fared thrice over the sea in his own craft, who were each of them entitled to thane-right. And it appears to me that Thorpe is somewhat hypercritical, when he asserts that in the compounds mass-thane and weofud, or altar-thane, the

* Thorpe, *ut supra*, i., 189.

word thane is not a title of honour, but used in its primitive sense of *servant* or *minister*.

That the word thane ever came to signify a servant or minister is, I apprehend, due to the necessity through which servants or ministers were secondary to the people whom they represented or served, and by whom they were employed. The terms mass-thane and weofud-thane were rather titles of courtesy, arising from the honourable grade accorded to those who served at the altar. Nor does it appear to me that there were necessarily two great classes of thanes, but that the king's thane was one who served the king in some position or another, just as the king's reeve was so called because he acted on behalf of the king.

By the *Constitutiones Forestae* of Cnut, four thanes are appointed in each province for the administration of justice, and four less thanes under each of them. The first four are to be selected *ex liberalioribus hominibus*; the less or minor thanes are explained as *quos Dani vero 'yoongmen' vocunt*, expressions confirming the suggestion that there was not any essential difference in rank or character, but merely of property or means. In the Secular Code, No. 15 illustrates the magisterial character of the thane, and the manner in which such appointments were then obtained, by enacting that whoso sets up unjust law shall forfeit his thaneship, unless he repurchase it of the king, and as he shall allow him.

It is important to note that, so recently as 1369, Thomas de Beyle was seized of two messuages and forty acres of land, held of the Bishop of Durham in thanage (thynagio), by the service of twenty shillings a year; and Blount quotes from *Testa de Neville*, that Adam de Prestwich held ten oxgangs of land in Prestwich and Farlesworth (Lancashire), in capite in thanage.*

* Blount, *op. cit.*, pp. 336 and 378.

The foregoing persons were but small landowners, but the existence of such a tenure raises the question, What service did it involve? and it would appear that, as thanes were sithcund-kin, their service would be the maintenance of peace in their respective counties. This, as before shown, is the reasonable interpretation of the words sithcund and lord; and, in times of disorder, the landed gentry have always been specially enjoined to assist in the maintenance of the Royal authority. The K. word *tanaise* is glossed by O'Reilly—a lord, a dynast, a governor of a country; and *tanaisteach*, swaying, acting like a thanist or thane, which is very corroborative of the suggestion.

The term reeveland cannot be regarded as territorial, but merely as indicating the land held with the office, and assisting to maintain its dignity and emolument. The office of reeve has been of such importance, and its title so long-lived, that it may be desirable to consider the derivation of the title, and the influence the office has had on the language. The A. S. rèfa apparently represents K. *ri-fa*, signifying under the king or lord, and therefore appropriate for the office of reeve, or steward.

From this root, and the tyranny and extortion practised by reeves, when agents to those who farmed the revenues and customs, or were themselves farmers, successors to the publicani of Roman sway, come the words reft, bereave, bereft; rive, riven, rift; reef, as applied to the gathering in of sails; and riever: from the copulative form ge-refa, grieve or grief, still in use in Scotland to denote the overseer or manager of a farm; also, grief, grievous, and their correlatives: and by substituting the *u* sound of *v* for the single *f* in the first form, come rue and rueful, ruin; and, with the prefix, gruesome.

In the Irish language are allied words, *reabh* (rave), a trick, craft; *reabhach* (ravac), subtle, crafty; *reubach*

(raibac), lacerative; *reubadh* (raibay), tearing; *reuban* (raiban), plundering, destroying; and *reuboir* (raibeer), a robber, a destroyer.

These words are abiding records of the oppression with which those officers discharged their offensive duties. They inflicted pain of mind, arising from loss and injury, and left a sense of wrong done which survives in metaphorical uses of their title, analagous to the current phrase which speaks of *taxing* a man's time or patience, his indulgence or temper.

It must not be forgotten that the reeves and their lords were the magistrates of the day, who carried into their own coffers a considerable part of all the fines consequent on conviction, and were the licensed dealers in that protection which the conqueror vouchsafed to a subjugated people.

.That the association of tax-gatherers with robbers is not far-fetched, appears from the following extract from *Institutes of Polity, Civil and Ecclesiastical*:—"It is right that reeves zealously provide, and always rightfully gain, for their lords; but now it has been altogether too much the case, since Edgar ended, so as God willed it, that there are more robbers than righteous; and it is grievous that those are robbers who should be guardians of a Christian people. They rob the poor without any blame, and at another time devastate the flock they ought to keep, and with evil pretexts defraud poor men, and set up unjust laws, in everywise to the injury of the poor; and oft and frequently strip widows. But whilom those men were chosen wisely in the nation, as guardians of the people, who would not, for worldly shame, nor durst, for fear of God, obtain anything by fraud, or make gain unjustly, but ever gained with justice; and since that it has been sought, by means of those above all who knew how most oppressively to cheat and deceive, and with falsehoods injure poor men, and most speedily to get money

from the innocent; since then God has been exceedingly much angered, oft and frequently; and woe to him, for his money, who has gained most of it by injustice, unless he desist, and the more deeply atone before God and the world." *

A remarkable illustration of the freedom with which titles were applied metaphorically is to be found in the last of the *Institutes*, which asserts that "the church is rightly the priest's spouse, and with him who is ordained to the church, no man, who recks of God's law, has thenceforth aught to do, unless, through capital crime, he foully forfeit it, and then shall Christ's 'scir-gerefa' be informed of it, and thereupon direct and judge as the books prescribe."

But in that, as in other cases, it is not impossible the term generally used is due to a confusion between two or more, incidental to the frequent introduction of a foreign element, arising from conquest, immigration, and other causes.

In connexion with territorial subdivision, the various courts, gemots, conmots, and 'things' should be considered. Though ultimately those assemblies were very useful in the maintenance of order, their origin, I believe, is due, like that of the territorial sub-divisions, to the necessity for revenue.

Adopting Thorpe's summary, the various kinds of assembly were:—

1. The folc-gemót, or general assembly of the people, whether it was held in a city or town (burg), or consisted of the whole shire. This meeting, it appears, was, on extraordinary occasions, summoned by the ringing of a bell, called the "moot bell," though its regular meetings were annual, viz., 'in capite Kalend. Maii.'

* Thorpe, *op. cit.*, ii. 321.

2. The 'shire gemót,' or county court, which met twice a year.

3. The 'burg-gemót,' which met thrice a year.

4. The 'hundred-gemót,' or hundred-court, which met 12 times a year in the Saxon times; but afterwards, a full (perhaps an extraordinary) meeting of every hundred was ordered to be held twice a year. This was the sheriff's *tourn*, or view of frankpledge.

5. Halimotum, A. S. 'Halle-gemót,' 'conventus aulæ hoc est curiæ dominicalis, manerii, vel baronis in villis et dominiis; seu tribuum, wardarum, et societatum, in burgis et urbibus.' See Spelman's *Voce Haligemot*.

6. Wardemotus, 'wardarum conventus vel curia.'

On the above I would observe that, according to the Domes of Edward the Elder, and of Edgar, the hundred-court was bound to meet once in four weeks, or thirteen times a year, and not twelve times only.

From the earliest record, those moots would appear to have been designed to serve fiscal purposes. Protection from injury, or compensation, therefore, was appraised at specified prices, as between the parties, and, in addition, a fine to the king or lord. Taking the first record, that of Hlothære and Eadric, in which the 'thing' is mentioned—long before the arrival of the Danes —if one makes plaint against another, the latter shall give security to the other to do him right, or forfeit twelve shillings to the king. And so of many others: If a man draw a weapon where men are drinking, and no harm be done there, he shall pay a shilling to the owner of the 'flet,' and twelve shillings to the king; but if blood be drawn, let him pay to the man his 'mund-byrd,' and fifty shillings to the king.

The Halimotum was the Manor Court; and it is well known many of those were most oppressive in the customs they enforced.

Allied to the Manor Court was the Barmoot, Berghmoth, or Berghmote, which is erected in Wirksworth, Derbyshire, in which wapentake, or hundred, the minerals are chiefly found, and the ore smelted. It consists of a Master and twenty-four Jurors, and decides pleas and controversies among the miners. The following rhymed version of the functions of this court, with references to the Statutes, is taken from Manlove's *Treatise on the Customs of Miners*:—

3 E, 6 Art. And suit for Oar must be in Berghmote court,
9 Thither for justice miners must resort;
16 E, i. c. 2. And two great courts of Berghmote ought to be
3 E 6, Art. 10. In every year upon the Minery;
3 & 4 P & M. To punish miners that transgress the law,
Art. 19. To curb offences, and keep all in awe;
26 Ed., i. c. 1. To fine offenders that do break the peace,
&c. Or shed man's blood, or any tumults raise;
To swear Berghmasters that they faithfully
Perform their duty on the Minery;
And make arrests, and eke impartially
Impanel Jurors, causes for to try;
And see that right be done from time to time,
Both to the Lord and Farmers on the Mine.

Juratores etiam dicunt quod Placita del Berghmoth debent teneri de tribus septimanis in tres septimanas super Mineram de Pecco.—Esc. 16 Ed. I.

The analogy between the raising of revenue and the milking of kine is of old date. It has been said that the Liverpool town dues were the milch cow, which enabled the Corporation to indulge in lavish expenditure. But the analogy was recognised by the Romans, if not before. In Latin, the crude form, *melge*, milk,* is the root of *mulcta*, a fine; and the crude form *lác*, to draw, is the root, not only of *lacta*, milk, but of *lacryma*, a tear, and *laceratio*, a

* The Irish for milk is *melg* and also *lacd*.

mangling, as though ancient taxpayers fancied the operation was not altogether as mild as milk, but had some resemblance to bloodletting.

The milk analogy is curiously preserved in the name of the Witenagemōt, the first part of which refers, I apprehend, to taxation, and to the duty of the gemōt to keep taxation within due limits, witena representing K. *uit-eneach*, teat-protection. On comparison with other uses of the word *uit* which survive, this conjecture will appear less fanciful than at first.

The name of the grain called wheat appears to represent K. *uit*, a teat, because, during the earing, each corn contains a milky juice, ultimately converted into flour; and no other British grain contains so much of that juice. Its resemblance, therefore, to the milk-secreting glands in mammals led to the application of the term.

Uit was also applied to witches, doubtless from the superstition that those unfortunate women suckled imps; and the word witch is manifestly only a modified pronunciation of K. *uit-ci*, the hound-teat, where, I apprehend, the word signifying hound is applied in contempt and disgust, as sometimes in the present day. The use in literature of wit for witch appears to have survived into the seventeenth century, and to be almost as much of a puzzle to glossarists as *Wappen*. Nares gives the following instances of its use, in all of which I think the meaning becomes clear, if the idea of witch be associated with the word wit.

In *As You Like It*, when Rosalind says :—

"Make the doors upon a woman's wit, and it will out at the casement; shut that, and it will out at the keyhole; stop that, it will fly with the smoke out at the chimney."

* Another form of the Irish for teat is *witche*.

Orlando punningly rejoins :—

"A man that hath a wife with such a wit, he might say—'Wit, whither wilt?'" iv. 1.

So Decker, in *Satirom*:—

"My sweet wit, whither wilt thou? my delicate poetical fury."

Again :—

"Wit, whither wilt thou? woe is me,
Th' hast brought me to such miserie."
Greene's *Groat's worth of Wit. Pref.*

And Middleton has :—

"C. Wit, whither wilt thou?
D. Marry, to the next pocket I can come at."
More, *Diss. Anc. Dr.*, iv., 394.

The primary duty of the gemōt, who came from different parts of the country, and knew the resources from which revenue could be derived, was to check the rapacity of the ruler, be he of what rank he might, so that sufficient was left for the calves, lest the herd be exhausted. This is still an important function of the successor to the Witenagemōt. In process of time, the superior information within reach of the gemōt would be accepted as evidence of the wisdom of their measures, and be cited to silence the discontented. Thus wit would acquire its subsidiary signification of knowledge and wisdom, as the verb, to think, is derived from the deliberative assemblies called *things*. In like manner, Pentecost was termed in this country Wit-tide, subsequently corrupted into white, that is fair, tide, which is the signification of the Welsh name, *Sulgwyn*.*

During the Roman period, tribute was collected in the form of grain, including wheat, which might thus become

* But the comforter . . . shall teach you all things! that is, make *wise* to salvation.

one of the synonyms of tax, and give their name of Whitfield to the various places of deposit, analagous to the Boonsfields, Coldfields, Coldharbours, and Caldecotes, which are supposed to have obtained their names from such uses.

The word *wite*, as penalty, appears to be another form of *wit*.

And from *wit*, in combination with K. *ting*, may be derived the names of such places as Whittingham and Whittington, whilst the Whitleys, Whitworths, Whitbys, and Whittons may have been additional granaries, like berewicks.

Of the whole of the courts, it may be said that, like the manor courts which still survive, they were primarily instruments of extortion, and consequently of oppression; and any assistance which they rendered to the cause of self-government and liberty was very far from the original intent.

To the latest period, the grant of every soc, or jurisdiction, was accompanied by the sac, or right of extortion; to carry the sack or bag in which fines and boons and presents were collected; and the popular detestation of the process is embalmed in the use of the words sack and ransack, with other compounds for pillage combined with brutality. Even the borough courts of towns incorporate were instruments of wrong and extortion to those who had not been admitted to the freedom of the borough; and this down to the reform of municipal corporations in 1836. Doubtless the association of burgesses with a common interest was an influence oftentimes potent against an oppressive lord, or a tyrannical sovereign; but this was only incidental, as they could help in the conflict of mightier interests, until, in the process of centuries, they were able to cope on more equal terms with rulers in Church and State. It is difficult to understand how the notion has arisen that courts were originally

instituted with the slightest intention of protecting the liberty of the subject, or were otherwise than instruments for maintaining the power of a conqueror, and the wealth of his treasury. This purpose is apparent to the student of *Domesday*, though the minuteness of that survey was greatly exaggerated in the A. S. Chronicle and other writings, showing with what caution the statements of early historians are to be received. Fortunately, it is now possible for almost everyone to compare the survey itself with the exaggerations referred to.

It is not intended to depreciate the inestimable advantages which municipal institutions have conferred on the English people, though, until forty years ago, many of the most suitable inhabitants of corporate boroughs were unfree, and many of the most important towns of the kingdom were unprovided with those institutions, just as the counties are now, not even retaining the courts referred to in the Domes. I conceive that the advantages which have been derived from municipal institutions were not contemplated at their inception, but are the incidental product of the centuries through which the institutions have existed. Their origin, I apprehend, must be sought in the wonderful genius which the Romans possessed for conquest and consolidation, for systematising during their long sway the minutest detail by which their authority could be strengthened, and the value of their much-prized possession enhanced.

To suppose that the rude and uncouth barbarians of Germany, or Scandinavia, could impart the elements of civilisation to the most civilised people in Northern Europe, is to outrage all historic probability, especially after the striking homage rendered by Charlemagne to Northern Anglia, in soliciting the aid of her brightest scholars in civilising his barbarous subjects. The eagerness with which the people of all surrounding countries flocked to England,

and the blood and treasure lavished by Continental sovereigns to secure this insular throne, and the greed of foreign ecclesiastics for preferment in Britain, are wholly unaccountable, if it be supposed that the character and condition of the peoples is reversed. Where there are so many eagles, the prey must be abundant. When the mineral wealth of the antipodes has induced the rulers of the British Empire to remove thither the seat of government, it may be conceivable that Sweyn and Cnut left luxurious and polished ease in Copenhagen, to encounter the rude discomforts of British savagery; that Norman William, fearing enervation and decay, braced the expiring energies of his nobles by seizing the English crown; and that Archbishop Theodore surrendered ecclesiastical repose for the hardships of missionary enterprise.

Far otherwise does the vision of our past history present itself to my view. I see, or think I see, indubitable traces of an overwhelming conquest and iron rule; a stern determination to shrink from nothing which should secure a valuable conquest, erewhile a dangerous ally to Continental tribes, whose subjugation was deemed important. This source of opposition being destroyed, the attractions of its scenery and climate, conjoined with its mineral and agricultural wealth, made England a favourite resort for those who wished to renovate disordered health, or to replenish decayed fortunes; but never was the Roman senate transported to its shores, though it was indeed, for a time, the resting-place of an Imperial general, the field where he gathered laurels for his brow, or won an empress for his throne. But "their hearts, untravelled, fondly turned to *Rome*," for all who coveted Roman sway knew it could be permanently enjoyed there only. Then, when the great change came, and the Romans retired from the Island, they left a large body of settlers, or the descendants of settlers,

whose interests and affections during four hundred years had become inwoven with Britain; and there were the wealthy and cultivated natives, who had learned to emulate the most eminent of Roman society, and to hold their own, just as something of the kind may be seen in Hindostan, after the lapse of little more than one century since the earliest British landing.

And if, when the paramount authority was withdrawn, the people were split up into different states, as interest or tradition suggested, in what way would such a result vary from that old tale often told, in the vicissitudes of nations?

That the least Britannic part of the population should be at the seat of commerce, near to the mineral treasures of the south and west, and that they should combine to protect themselves against their more Britannic neighbours; that the latter should aggregate in sections, under leaders chosen from the great governing families of old; all this is equally consistent with history. But that a pic-nic party, in three keels, barbarous and uncouth, should land and overthrow all the trained veterans of the Roman armies, who had settled on their allotments, and abode in their new country, together with the brave and sturdy natives who supplied sinew and muscle for those armies, gladiators for the arena, and captains for the Varangian guard — this supposition is so monstrous, and so utterly at variance with all historical probability, it is difficult to conceive how it has obtained credence. And when it is considered that the chief authority for this marvellous assumption is an ignorant, superstitious, narrow-minded, bigoted partisan, who did not live until three hundred years after the events he is supposed to record, that credence seems allied to the belief in silly tales of senseless miracles, which form the staple of his so-called history. When the foundation is so thoroughly bad, how can the superstructure stand?

HISTORIC NOTICES OF THE OLD PHILOSOPHICAL AND LITERARY SOCIETY OF LIVERPOOL.

By J. A. PICTON, F.S.A.

Although the present Literary and Philosophical Society has attained a period of its existence which may almost be called venerable, it is not the first of the kind or of the name which has existed in Liverpool. I have recently been engaged in collating the extensive collection of MSS. relating to local affairs, belonging to the Corporation. Amongst them I have met with a number of documents relating to a society established here between ninety and a hundred years ago, which may not be without its interest as bringing to light the position of literature and science, and the remembrance of those who cultivated it amongst us, at that period. This was not the first attempt in Liverpool towards association for literary purposes. In the year 1750 a few gentlemen were in the habit of meeting for the discussion of literary subjects at the house of Mr. William Everard, in St. Paul's Square. These meetings were kept up with some spirit for a number of years, and their acquisition of books ultimately led to the establishment of the Liverpool Library, into which the Society appears to have merged, for after that time (1758) we have no further record of its existence. It was in 1779 that the Society originated to which I now wish to call attention. A century has made a wonderful change in the aspect of our town. Its population, its extent, its commerce, its wealth have multiplied at least fifteen-fold. Whether its intellectual advance has been equal to its material progress, I will not take upon myself to say: each inquirer will judge

for himself. At the period to which I am now referring, the population of Liverpool was about 40,000. The town extended northwards as far as St. Paul's Square and the Canal, southwards to Kent Street, and eastward as far as St. John's Church. The central parts of the town were closely and densely packed with buildings. The wealthier classes had migrated to Church Street, Duke Street, Hanover Street, and the neighbourhood, which was the fashionable quarter. At that time a provincial town was intellectually left very much to its own resources; intercourse with the metropolis was infrequent and difficult, but with all its disadvantages there was a small circle in Liverpool which cultivated literature, science, and art, several of the members of which have left their mark behind them. William Roscoe had recently published his poem on "Mount Pleasant," which was very favourably received by the public; John Newton had not long before left the Custom House of Liverpool for more congenial work as curate of Olney. A vigorous attempt had been made towards the cultivation of the fine arts by means of an annual exhibition, which first took place in 1769. Several artists of considerable eminence had developed their talents in Liverpool; amongst others Richard Wright, R.A., the marine painter, many of whose works have been engraved by Woollett; George Stubbs, who, as a painter of horses, has never been surpassed; Richard Caddick, William Tate, and Thomas Chubbard, portrait painters of considerable eminence in their day; and P. P. Burdett, an engraver, whose works are well known, and for whom is claimed the invention of the aquatint process of engraving. Medical science had worthy representatives in Doctors Thomas Houlston, Joseph Brandreth, and John Lyon; and Henry Park, as an operating surgeon, had a fame far beyond this locality. It was at this time—about 1779—that a proposa was made for the establishment of a literary and

scientific society, which should form a centre for mental cultivation in Liverpool. At first it was called "The Society for the Promotion of Useful Knowledge," anticipating by half a century the far more celebrated society bearing the same name, but ultimately it took the name of "The Liverpool Philosophical and Literary Society," and was inaugurated on the 1st of December, 1780. Several of the members had been connected with the society of 1750. Mr. William Everard, at whose house the first society had met, though not the first secretary of the new society, subsequently acted in that capacity. The first printed list contains thirty names, to which others were subsequently added. The list is very interesting, from its local associations and the family connections of several of the members. Eight of the number were medical men, two were clergymen of the Establishment, two were Unitarian ministers, one attorney, eight were merchants, three schoolmasters, one dockmaster, one musical professor, two architects and surveyors, three tradesmen, and one styled gentleman. There was also one lady member, Miss S. Heywood, belonging to a family who have for nearly a century and a half occupied a distinguished position in the commercial world. I will briefly allude to a few of the names. James Currie, M.D., was the first president. He is well known as a vigorous political writer. A pamphlet issued by him at the commencement of the war in 1793, under the pseudonym of Jasper Wilson, excited extraordinary attention. Three large editions were sold in two months, besides reprints in Scotland, Ireland, and America. It was also translated into French and German, and circulated abroad. Dr. Currie is, however, better remembered as the earliest biographer of the poet Burns. He resided at 22, Church Street. His son, William Wallace Currie, was the first Mayor of Liverpool under the Municipal Reform Act. The first Vice-Presidents were Thomas Avison, surgeon

to the Dispensary, grandfather of the present worthy Town-councillor of the same name, and William Rathbone, jun., grandfather of Mr. William Rathbone, one of the Members for the Borough. The first Secretary was James Williamson, attorney, Castle Street, son of Robert Williamson, bookseller and printer, who established one of the first newspapers, and whose portrait hangs in the Free Library. Of the private members a few names may be mentioned. John Baines was the master of the Free Grammar School, which at his decease was abandoned, but revived in some degree half a century afterwards in the establishment of the Corporation Schools. Dr. Jonathan Binns was a leading member of the Society of Friends, and was the father of the local antiquary, whose valuable collections were purchased by the Corporation, and now form part of the Free Public Library. Matthew Gregson was an eminent example of industry and success in business and devotion to literary pursuits. He was the author of the "Fragments for the History of Lancashire," and contributed for many years on antiquarian and local subjects to the *Gentleman's Magazine* and other periodicals. He was the collector of the voluminous MS. records from which these particulars are taken. Captain W. Hutchinson was in many respects a man of note. He was born at Newcastle-on-Tyne, and was brought up to the sea in a small collier. In 1750 he was in command of the Lowestoft frigate. During the seven years' war with France and Spain, he was commander and part owner of the privateer ship *Liverpool*. In 1760 he was appointed dock-master at Liverpool. He was a man of very varied qualifications. He was the inventor of reflecting mirrors for lighthouses, the first of which was erected at the Bidston Lighthouse in 1763. In 1794 he published a treatise on naval architecture. From January, 1768, to August, 1793, he continued a series of observations on the tides, the barometer, weather, and winds, the MSS. of which are in the

Athenæum and Lyceum Libraries. From these were obtained the data by which the Holdens, father and son, calculated the tide tables. He was also the founder of the Marine Society, and contributed to all the benevolent institutions of the town. He died February 14, 1801, and was interred in St. Thomas's Churchyard. Henry Park was a very distinguished surgeon, one of those who have contributed to raise the fame of the medical and surgical school of Liverpool. For more than fifty years he was actively engaged in his profession, first in Basnett Street, and afterwards in Bold Street. He was one of the first, if not the very first, to practise excision in cases of carious joints. His published work on this subject passed through several editions. He died at Wavertree in 1820, in the 86th year of his age. Dr. Michael Renwick was also an eminent physician in the town during many years. William Everard, an architect and surveyor, in St. Paul's Square, was an earnest student, both in science and literature. By his exertions an astronomical observatory was erected by public subscription in Hope Street, the first stone of which was laid with great *éclat* on the 9th September, 1766, by the mayor, Mr. John Crosbie. It was carried out by Mr. Everard, who expended considerable sums upon it, which he never got repaid, and the building was suffered to go to ruin. Mr. Everard was also one of the founders of the Lyceum Library. Charles Eyes belonged to a family who for more than a century occupied a prominent position in the town as surveyors. Most of the maps of Liverpool during the last century were from their hands. Charles Eyes constructed the published map of the town and its environs in 1785. Dr. James Gerard was a physician, and occupied the civic chair in 1808. Several other names might be mentioned, but I have said enough to show that the Society which I am commemorating had within it the elements of vitality and success. Their meetings were first

held in St. James's Coffee House. Afterwards they met at each other's houses; and finally settled down in apartments in Leigh Street, which were furnished, and provided with books and philosophical instruments. Some of the subjects discussed sound rather odd at the present day. The following are specimens:—"Why is lime after calcination affected with such a violent calidity when sprinkled with water?" "Why does light reflected from the moon produce no sensible heat?" "Whether there be any inherent instinct in animals beyond the common appetites of hunger, thirst," &c. "On the uses and disadvantages of commerce." "On the standard of taste," &c., &c. For a time the society appears to have gone on prosperously. The circumstances of the times were in some respects more favourable than those of the present day. The town was so small that none of the members resided more than a quarter of an hour's walk from the place of meeting. The domestic habits also gave facilities. The hour of dining was usually one or two o'clock, so that the evenings were at liberty for any social gathering, and there was not the same distracting multiplicity of objects, all clamouring for attention and support, which exists at the present day. Be this as it may, historical truth compels the record that after a time the zeal of the members began to flag. It was found necessary to pass a resolution, "that for the future every member in rotation be obliged to propose a subject, and deliver a written paper upon it." This was certainly a signal of distress—a desperate remedy, which, I fear, if carried out in our present society, would cause many a hiatus in our ranks. To some extent it appears to have been effectual, for the records continue in due order for a considerable time after this. Suddenly, however, on the 6th October, 1783, we find recorded in a beautiful handwriting, apparently in that of the Quaker president, Jonathan Binns, as follows:—"At a meeting of the Philosophical and Literary

Society, holden the 20th September, it was agreed that the said Society be dissolved. This conclusion was submitted to with regret by some of the members; but the almost total want of zeal and attention in the larger number seemed to leave no alternative. For the purpose of paying the rent and other expenses of the Society, it is proposed that the books, furniture, and other property be sold by auction among the members at the apartments, on Saturday next, the 11th October, punctually at seven o'clock in the evening. If you do not personally attend, it will be understood that this proposal meets your approbation and consent. If any member have books or other property of the Society, it is desired that he will not fail to bring them before the above hour. Those members who paid no attention to the last summons, if they do not attend this meeting, or certify by letter to the President, at or before the meeting, that they will pay their arrears, will be deprived of a dividend of the sum remaining after the payment of the Society's debts.—J. B., President." As the sailor said to his captain, when the boarders swarmed up the side, "No sham here, by Jove." The Quaker President means what he says, and no doubt carried out thoroughly his programme. Of this, however, I have no information, for here the record abruptly ends. Tacked to it is a dissertation by Mr. Matthew Gregson, evidently read before the Society, "On the explanation of the legend on the common seal of the Liverpool Corporation," which, if it does not go back quite to the Creation, at all events commences with the origin of writing and the Roman dominion in Britain. A great many pages and much learned inquiry are expended in leaving unexplained what is after all a very simple matter, and has since been perfectly cleared up by the discovery of impressions of the original seal, of which the present is a blundering copy. And thus closes the record of the original "Liverpool Philosophical and Literary Society." It occurred

to me that I should only be doing an act of justice to the memory of those who have preceded us in keeping alight the torch of literature in this locality, if I brought under public notice a little episode which is worthy of being placed on record. If, as Horace sings,

> "Vixêre fortes ante Agamemnona
> Multi; sed omnes illacrymabiles
> Urgentur," *

it shall not, in this instance,

> "Carent quia vate sacro."

Although the Society was dissolved, its spirit was not extinguished:

> "E'en in its ashes lived their wonted fires."

In 1790 a small literary club existed, to which Edward Rushton the elder, the blind poet, belonged, and out of whose discussions issued the germ which afterwards developed into that noble institution, "The School for the Blind."

It is pleasing, also, to record, that our own Society has a sort of filial connection with the subject of this paper. Out of the first names enrolled in the present Society, two, the Rev. J. Yates and the Rev. Joseph Smith, had belonged to that of 1780, and six other members, Messrs. William Wallace Currie, William and Richard Rathbone, Joseph Brooks and John Ashton Yates, and Thomas Binns, were the sons of gentlemen who had belonged to the previous Society. We

* "Before great Agamemnon reigned,
Reigned kings as great as he and brave,
Whose huge ambition 's now contained
In the small compass of a grave;
In endless night they sleep unwept, unknown—
No bard had they to make all time their own."

can thus trace back in unbroken connection for one hundred and twenty-four years, from 1750 to the present day, the chain of literary and scientific efforts in this locality. May we hope that the next period of similar extent will have to record far greater triumphs, and much more rapid development, in every pursuit which can adorn and dignify humanity.

ILLUSTRATIONS OF GRIMM'S LAW.*

By Rev. E. M. GELDART, M.A.

Before I proceed to illustrate Grimm's Law, I must endeavour to explain it. Why is it called Grimm's Law? and what is it that is so called? To answer the first of these questions first. It is called Grimm's Law because it is a law first discovered and exemplified by Jacob Grimm, in his celebrated German Grammar and History of the German Language.

But what, then, is Grimm's Law? It may be summarily described as a law of phonetic change, according to which certain sounds in certain languages regularly reappear as certain other sounds in certain other languages. The full significance of this important rule will be made clearer by a brief review of the state of philological speculation from the earliest times. Philology is a wide term, and I must be careful how I use it. It is, however, generally employed to mean what Archbishop Trench has called the *study of words*. If any one wishes to see how words were studied by the ancient Greeks, let him read the *Cratylus* of Plato. In what proportions jest and earnest are mingled in that dialogue has been the subject of much controversy, which I do not presume to decide. But when Plato derives δίκαιον, just, from διὰ ἰὸν, *i.e.*, that which *goes through*, from διά, through, and ἰόν, going, he shows the kind of etymology which, especially among the Sophists,

* In preparing this Paper I am greatly indebted to the *Grundzüge der Griechischen Etymologie*, of Georg Curtius, Dritte Auflage, Leipzig, 1869. Indeed, the only part of the present treatise which can lay claim to originality is the comparison of Albanian and Welsh words.

was in vogue in his time. The radically false principle on which such derivations are founded, is that of appealing to words, in order to confirm a presumption of the thing already in the mind. Following in his footsteps, Aristotle, much more seriously, as became his prosaic nature, having settled that the principle of justice was that of equal distribution, had no hesitation in deriving δίκαιον from δίχα, which means "in halves"; and, again, convinced that μάκαρ, blessed, must mean "very happy," he had no doubt that the last syllable, καρ, was the same as the χαιρ-, in χαίρειν, to rejoice. How baseless these conjectures were we shall hereafter see. With no knowledge of any language but their own, the ancient Greeks indulged freely in this kind of guesswork. This derivation was mere haphazard. The slightest correspondences of sound and sense were sufficient to mislead them. Etymology, moreover, was pursued chiefly as a means to an end. It was used as a mere instrument to support a favourite theory. Thus the Stoics had a theory that the sound of the word must in some way or other remind us of the thing, either from its resemblance to the thing itself, or to its opposite; it did not much matter which. Hence, *lucus à non lucendo*, which we might parody in English by saying a wood was called a *wood*, not because it *would*, but because it *would*n't, let in the daylight. This not remotely reminds us of a hieroglyphic riddle of modern days, in which a tea-pot and a pig stand for the familiar proverb, "No rose without thorns." Do you ask why? The tea-pot is "no rose," and the pig, though provided with bristles, is utterly destitute of thorns. Thus Chrysippus derives 'Απόλλων from ἀ, *not*, and πολλοὶ, *many*, because, he says, he is one and not many, as though that could not be said of any other individual, human or divine. After a while the Greek grammarians relieved the philosophers of this part of their studies, and the celebrated Herodian

gives some pretty fair samples of derivative ingenuity, when he explains μάγειρος, the cook, from ἀγείρω, to gather, disregarding the initial μ; and gravely tells us that Ἀσκληπιὸς, Æsculapius, one of the eponymous heroes of medicine and surgery, is the leg-soother, from σκέλη, legs, and ἤπιος, soothing.

By degrees the Alexandrine meaning-mongers elaborated a system by which anything could come out of anything. Here, above all, the need for some such law as Grimm's was apparent. For there was absolutely no limit to the changes which they allowed. Παρνασός was so called because the ark, or Λάρναξ, of the Greek Noah, Deucalion, first found a mooring on its summit. It used, they said, to be called Λαρνασός. And yet a certain check was found to these vagaries in the recognition of the fact that at least there were certain letters more likely to interchange than others, as, *e.g.*, χ, κ; λ, ρ. The *Etymologicum Magnum*, the great repository of such guesses, warns us that ι is never changed to α, a position fully confirmed by subsequent research. When we add that the old grammarians had no conscience at all about adding on a letter, or indeed any number of letters, at the beginning of a word, thrusting in whole syllables in the middle, and making any given letter play leap-frog over the back of its neighbour, that they made no distinction between the stem of a word and its terminations, we have given a faithful, though but feeble, picture of the chaos of ancient etymology. There was much excuse for these old Greeks. They knew no language but their own, or at most, in later times, their own and a little Latin. They thought the Attic dialect was the oldest and purest Greek, and therefore the fuller forms of Homer gave rise to the idea that words in process of corruption might grow and swell in bulk; and as they had no knowledge of the causes which determined the variations between one

Greek dialect and another, they supposed that the apparent changes which words underwent in passing from one dialect to another, might just as well take place within the limits of the same.

For many centuries after the revival of learning, at the Reformation period, in modern Europe, the *literati* of a later day were not much in advance of their classical precursors. They knew something, indeed, of more languages than one, namely, besides their mother-tongue, whatever it might be, they were acquainted with Greek, Latin, and Hebrew; and, doubtless, hence arose the first germinal conception of a comparative grammar and dictionary. But a little knowledge is a dangerous thing. It was readily assumed that Greek was not the sister, as we now see to be the case, but the mother of Latin; and men etymologised in accordance with this erroneous prepossession. Thus Julius Cæsar Scaliger, 1584, derived *pulcher* from πολύχειρ, and *ordo* from ὄρον δῶ, in defiance of sense in the first case, and of grammar in the second. In the seventeenth century, Gerhard Johann Voss saw no difficulty in getting *similis* from μιμηλὸς; the *s* in *plus* from the ν in πλέον; the *g* in *seges* from the *r* in *serendo*; the *v* in *vello* from the τ in τίλλω. The notion that Greek was the primitive language from which all others were derived, led to the attempt to reduce Greek itself to its simplest elements. It was generally taken for granted that the shorter forms were necessarily the most ancient, and this idea was followed out as late as 1846, by Anton Schmidt, to the last extreme of logical simplicity, when he proposed to derive the whole Greek language from the single letter ἱ, and the whole of Latin from the syllable *he* or *hi*. If men went further back than Greek, they went to Hebrew, or to Basque, and the less they knew of Hebrew or of Basque, the readier they were to believe that all the languages of the earth were descended therefrom. An end was put to such conjectures,

now nearly sixty years ago, by the German Franz Bopp, who proved, what others besides him had for some years suspected, that Greek and Latin alike are but links in a linguistic chain that stretches from India to the West of Europe. Bopp was the founder of comparative grammar. He showed that a certain class of languages were at once distinguishable from the rest, by having a common system of conjugation and declension. And the clearer and more certain their connection seemed, the more did they appear to be cut adrift from others, like Basque and Hebrew, between which and themselves no *such* resemblance could be traced; while, on the other hand, many of these other languages were capable of being arranged together in separate groups on the same principle; thus a comparative grammar of Hebrew, Arabic, and Syriac is possible, as well as a comparative grammar of Sanscrit, Zend, Greek, Latin, Slavonic, Celtic, and the Teutonic dialects. But there is no such thing as a comparative grammar of Sanscrit and Hebrew, except by comparison you mean contrast. In beginning with a comparative grammar instead of with a comparative dictionary, Bopp began at the right end. It is much easier to be certain you are dealing with the same things, about whose meaning there can be no doubt, when you compare endings, numerals, and prepositions, than when you compare names of things in general, all of which may very well be called by several different names, as, for instance, we speak of a horse and a steed; an ox and a steer; a pig and a swine; a cap and a hat; a dress, a garb, and a vesture, raiment, attire, clothes, with little if any distinction in sense, at least as regards present usage, whereas we have but one word for one, two, three, etc., respectively; nor can we for the most part form the plural of a noun, or the past tense of a verb, in more than one way. But Aug. Pott followed, and indeed outstript Franz Bopp's comparative grammar, by a compara-

tive dictionary of the Indo-Germanic languages; and Jacob Grimm worked out in his German Grammar and History of the German Language the same results in greater detail, and with more special reference to the Teutonic tongues. Moreover, he established beyond the reach of dispute that which we call Grimm's Law, and which put an end once and for ever to the random guesses of previous philologists, which had proceeded on the assumption that all those letters which even faintly resembled each other in sound, were liable to be interchanged between one language and another, or within the limits of the same, especially those that were formed by the same parts of the organs of speech. Comparative philology, dealing with the Indo-Germanic languages, with which alone Grimm was concerned, shows upon the contrary that whereas a certain number of consonants steadily stand their ground unaltered by all vicissitudes in Sanscrit, Zend, Greek, Latin, Sclavonian, Celtic, and Teutonic alike, others as certainly changed in passing from one language to another, and that not at haphazard, but by an undeviating law, and that the vowels also, though their behaviour is somewhat more erratic, are by no means altered at random. Of the old system of arbitrary guesswork the taunt was true enough, that consonants went for nothing, and vowels for something less. Now, on the other hand, as I propose to show, vowels go for something and consonants for a great deal more. The following table exhibits the changes which regularly occur, and which I shall now proceed to exemplify. The first column shows us the original sounds to which we are led by a comparison of the forms which words assume in the various principal Indo-Germanic languages. Thus you see that though Sanscrit is the most primitive of these tongues with which we are acquainted, yet it by no means represents the earliest phonetic condition of the speech of which it is a version. It is as though we had in our hands

Primitive Indo-Germanic ideally restored.	Sanscrit.	Zend.	Greek.	Italian.	Teutonic. Gothic.	Teutonic. Old High German.	Solavonian.	Lithuanian.	Albanian.
a	a	a e o	ă ε ο	a e o	a i u ai au	a i u eo	a e o ŭ	a e i o u	a e o ẹ††††
â	â	â	ā η ω	â ê ô	ê ô	â ô uo	a o	a o ė**	â ŏ
i	i	i	ῐ	i	i ai	i e	i ĭ	i	i
î	î	î	ῑ	i	ei	î	i	y	ī
u	u	u	ῠ	u	u au	u o	u o y ŭ	u	u ụ§§§
û	û	û	ῡ	u	u?	û	u y	u	ŭ
ai	ê	aê	αι ει οι	ai ê oi ae oe	ai	ei	ě§§ oj	ë ei	
âi	âi	âi	ᾳ ῃ ῳ	î û			aj	ai	
au	ô	ao éu	αυ ευ ου	au o u	au iu	ou ô iu io	u ov	ů***	
âu	âu	âu	āυ ηυ	au			av	au	âu
k	k kh k′ ç*	k kh c† ç	κ	c g (umbr. ç)	h (g)	h (g)	k č c s	k sz	k (h) k′ g (t)
g	g g′††	g gh j†† zh§ z	γ	g	k	k (ch)	g ž z	g ž§	g g′ k
gh	gh h	g gh j zh z	χ	h initial, g in mid.	g	g (k)	g ž z	g ž§	h z ð
t	t th	t th	τ	t	th (d)	d	t	t	t
d	d	d dh	δ	d	t	z sz	d	d	ð d
dh	dh	d dh	θ	{ Lat. f in. d, b mid. | Osc. & umbr. f. }	d	t	d	d	d
p	p ph	p f	π	p	f	f v (b)	p	p	p
bh	bh	b (w)	φ	{ Lat. f in. b mid. | Osk. & umb. f. }	b	b (p)	b	b	b (g) z f
ṅ	ṅ ñ	ñ ṅ	γ before gutturals	n	n	n	n	n	n n′****
m	m	m	μ	m	m	m	m	m	m
r	r	r	ρ	r	r	r	r	r	r ṙ
l	l	r	λ	l	l	l	l	l	l l′****, y final
j	j	y	ʽ initial	j	j	j	j	j	y
s	s sh	s ç sh h	σ, ʽ initial	s (r)	s (z)	s (r)	s ch š	s	s š g′
v	v	v	ϝ	v	v	w	v	v	v

* k′ = *ch* in *church*: ç = s palatal sometimes heard in the mouths of children who cannot pronounce our *sh*.

† c (Zend) = k′ Sanscrit, and č Slavonic, while Slav. c = German z pron. *ts*.

†† g′ = j in English and in Zend. The Albanian k′ and g′ respectively are similar.

§ zh, ž = sound of *s* in *pleasure*; or French j: ž in Slav. and Albanian, and sz in Lithuanian = sh in English and Zend.

§§ ě = yea in year, and is similar to Lithuanian ë.

** ė long, narrow, *ay* sound inclining to ee.

*** ů like oa in Soar.

††† ẹ as French e in *le*, *de*, &c.

§§§ ụ French u, German ü.

**** l′ and n′ like Spanish ll and ñ respectively: *i.e.* liquid.

†††† ṙ liquid r.

These various transliterations might easily be made more consistent, but only at the expense of disturbing existing usage.

a number of MSS., say, A, B, C, D, E, F, G, H, along with their subordinate copies, which we may liken to the minor dialects. Now, comparing B, C, D, E, F, G, H together, we find that in most points where they agree, they also agree with A. Hence A is the oldest version; but nevertheless here and there they agree together, yet differ from A. Thus they point back to some earlier MS. than A itself; more like to A than to any of them, on the whole, and yet agreeing with them in those points wherein they differ from A and yet agree together. Take the first of the consonants, *k*, beginning in Sanscrit fashion, which is more philosophical than our Hebrew alphabetical order, inasmuch as it proceeds from the back of the throat to the teeth outwards, starting with the simplest, hardest guttural sound. Now this *k* is not constant in Sanscrit, nor in Zend, nor even in the Slavonic dialects, but appears in the former two, sometimes as *kh* (as in *inkhorn*), sometimes as *k'* = *ch* in church, sometimes as *ç* or palatal *s*, a sound very like that which Germans give to *s* before *t*, as in *stand, stunde, stumpf*, a kind of intermediate, as it seems to us, between *s* and *sh;* while in Slavonic it likewise appears frequently as *č, c, s*, and in Lithuanian often as *sz*, pronounced *sh*. The same thing is repeated almost exactly in its various stages in Italian and French; Italian giving us the hard palatal explodent *c*, *cento* for *centum;* French, the palatal sibilant, as *chercher, charité*, for *cercare, caritas*, and finally the dental sibilant, as in *cent, certain*. The whole analogy of language generally shows us, then, this tendency of a *k* to pass into a palatal, but none on the part of a palatal to pass into a *k*. Hence, if we find *k* in Greek, hard *c* in Latin, standing where *ç* stands in Sanscrit, in spite of the greater antiquity of Sanscrit forms upon the whole, we immediately conclude that the *k* sound preceded that of *ç*.

Now, let us begin with a well-known word, of whose

meaning there can be no doubt. The Sanscrit for *ten* is *daçan*, the Zend or Old Bactrian is the same *daçan*. But we are not surprised to find in Latin *decem*, and in Greek δέκα, showing us the oldest Indo-Germanic form to have been *dakan*, or *dakam*. The *a* in Sanscrit has, as the table shows, three optional forms in Greek, α, ε, ο. Two of these are represented here, for the first *a* appears as ε and the second as α. In Latin the same choice of vowels holds good, and in this case *a* becomes *e* in both places. The final ν in Greek frequently falls away; thus the whole form is explained. In Albanian, the original *k* preserves its explodent sound, but has advanced, in articulation towards the teeth, so far as to become *t*; a phenomenon paralleled by numerous instances both in Albanian and Greek, though by no means so frequent in the latter language as to rise to the rank of a law. The Albanian for ten is δετ̧ε. In Old Bulgarian or Slavic the sibilant tendency prevails, and we have *desę-tĭ*, the *tĭ* being termination. Lithuanian, a kind of cousin of the Slavic, gives us *dészim-tis*, where you see the same ending recurs. In Welsh, a Cymric dialect of the Keltic tribe of speech, we get *deg*,* in which the *k* has simply softened to a *g*. But if we turn to our table to construct the Teutonic forms, we find that in Gothic the *d* becomes *t*, the *k* must become either *h* or *g*, the *g* being possible in the middle of a word, while our original *a* will either remain as it is, or else become *i*, *u*, *ai*, or *au*.

Now the Gothic for *ten* is *taihun*, where these conditions are fulfilled; but in Old High German we get *z* for *t*, and so *zehan* for *taihun*. And, correspondingly, in modern Dutch or Low German, and in English, another Low German dialect, we get *tien* and *ten*, while M. H. G. gives us *zehn*.

Now here I shall digress for a moment to illustrate this latter point. You might think it was matter of chance that

* The softening of a final tenuis seems almost a law in Welsh.

z in *zehn* answers to *t* in *ten*. But when I show you *zinn*, High German for *tin*, *zitz* for *teat*, *zapf* for *tap*, *zelt* for *tilt*, *zug* for *tug*, *zähre* for *tear*, *zehren* for *tear*, *zählen* for *tell*, *zoll* for *toll*, *zu* for *too*, *zunge* for *tongue*, *zeche* for *tick*, *zaun* for *town*, *i.e.*, a fenced place,—for *zaun* means fence in German, and *tuin* means fence in Dutch,—*zähmen* for *tame*, *zacke* for *tack*, *zeit* for *tide*, and *zeitung* for *tiding*, while *tidy*, *zeitig* really means in time, just as *pünct-lich*, from the Latin *punctum*, means in German both *punctual* to time and neat in dress; *zipfel*, diminutive, from *zipf* and *tip*; *zimmermann*, the carpenter, *i.e.*, the *timberman*; *zunder* and *tinder*, *zwanzig* and *twenty*, *zween* and *twain*, *zeichen* and *token*, *zweig* and *twig*, *zwicken* and *tweak*, *zwirlen* to *twirl*, *zwist* a *twist*, also a quarrel, *i.e.*, a complication, as the Greeks say, συμπλοκή: *zwitschern* to *twitter*; *zwölf*, *twelve*; *witz*, *wit*; *baize*, *bait*; *katze*, *cat*; *spitze*, *spit*; *pfütze*, *pit*; *schlitzen* to *slit*; *sitzen* to *sit*; *setzen* to *set*; *wetzen* to *whet*; *grütze*, *grit*; *würze*, *wort*; *spritzen* to *spurt*; *waizen*, *wheat*; *münze*, *mint*, in both senses; *holz* and *holt*; *filz*, *felt*; *schnauze*, *snout*; *schwitzen* to *sweat*; *er-hitzen* to *heat*; *schürze*, *shirt*, and *skirt*, probably the Saxon and Scandinavian forms respectively for the same word, with slightly different senses; *netz*, *net*; *schmerz*, *smart*; *herz*, *heart*; *klotze*, *clot*; *glotzen* to *gloat*, I think you will allow that law and not accident is at work. Regularity here, then, you will all admit.

But, turning again to our table, you will perhaps suppose that the reason it answered so neatly was that it was drawn up to suit that particular word. If so, it will not suit many others. But now take another word. Δάκρυ is Greek for tear. This, in Latin, is *lacruma*; but the Latin grammarian, Festus, tells us, "*Livius dacrimas pro lacrimas saepe posuit;*" so that here we have a trace of an older Latin form, *dacruma*; *ma* we know to be an ending, as in *fama*, talking, fame,

from the root *fa-*, to speak, infinitive *fa-ri*, other derivatives, *fa-bula*, a little speech, a tale; *fa-tum*, that which is spoken, the decree of the gods, fate. We cannot trace this word in Sanscrit nor Slavonic, but in Gothic it appears quite simply as *tagr*, a tear; *tagr-ja*, to weep; like Greek δακρύω; in Old High German, *zahar;* in Modern High German, *zähre;* and in English, *tear*.

Now look at English *tear*, and German *zehren*. Gothic *tah-ja*, I tear, shows us the same root, but minus the intensive *r*, just as we still say *blab*, as well as *blabber; blub*, as well as *blubber*. In Old High German we get *zâh-i;* M. H. G. *zähe*, tough, that must be torn; in Greek the Gothic root *zah-* appears as δακ-, in δάκ-νω, I bite. This root is nazalised in modern Greek, where we have δάγκ-ωμα, a bite; δαγκάνω, I bite; doubtless from some ancient dialect; even in Sanscrit we get *dáç-âmi*, I·bite; *dáçma*, a bite. Here, too, again you see Sanscrit *ç* = Indo-Germanic *k*. So, again, we have Sanscrit *diç-âmi*, to show; *diçâ*, a showing, a direction, a quarter of the heavens. This appears in Greek as δείκ-νυ-μι, I show; δίκη, a showing, an award, a verdict, justice. In Latin, *dico*, to show, to say; *causi-dic-us*, a cause pleader; *ju-dico*, for *jus-dico*, to show the law, to judge; *in-dico*, to point. In Goth., *teih-a*, I declare. In Old High German, *zeihu;* Modern, *zeihe*, I accuse, convict; as well as *verzeihe*, *I excuse;* and with the *g* instead of the *h*, *zeigôm*, I show; M. H. G., *zeige*. *Kalamas*, in Sanscrit, is a sort of rice, or a reed for writing. This answers to Greek κάλαμος, a reed; καλάμη, a stalk. Latin, *calamus* and *culmus;* Albanian, *kălam;* Slavonic, *slama* for *klama;* but in the Teutonic languages we must have *h* for an initial *k*, and so we get, O. H. G., *halam;* Modern German, *halm;* and English, *haulm*.

So, too, to Latin *culmen*, the top, the English *helm* seems to answer. To the Latin *collis*, the English *hill;* perhaps

to the Latin *celsus*, high, the German *hals*, neck, as the highest part of the body. To the Greek *κάρτα*, strongly, answers the English *hard;* while to the Greek *καρδ-ία*, Latin *cor*, for *cord*, gen. *cordis*, corresponds the English *heart*. So, too, *cornu* in Latin is *horn* in German and English. *Caput* in Latin is *haubith* in Gothic; *heafud* in Anglo-Saxon; Dutch, *hoofd;* English, contracted, *head*. Κώμη, in Greek, a village, is represented by *home, ham;* Gothic, *haims;* G., *heim;* whereas in Lithuanian *kēmas* the *k* remains intact. *Citra*, in Latin, becomes *hither; citerior*, in Latin, is as though we should say *hitherer* in English.

So, again, *κίω*, to go, to move, in Greek; the Latin *cio* and *cieo* appears to be the English *hie*, in *hie* away. Κλέπτω, to steal, in Greek, Latin *clepo*, becomes in Gothic *hlif-a; hliftus* is a thief, answering to Greek *κλέπτης*, modern Greek *κλέφτης*; from this noun we get the derivative verb, *to lift*, the *h* dropping away in modern Teutonic languages; hence a *shoplifter*.

So, again, G. *κλίνω*, Latin *clino*, becomes in O. H. G. *hlinêm*, in M. H. G. *lehne*, in English *lean*. The Greek for to hear is *κλύω*; Sanscrit, *çru-* for *kru-; çru-tis*, a call; *çrav-as*, fame. I may mention that in Sanscrit derivatives, when a vowel is added to roots ending in *u*, that *u* regularly becomes *av*. In Latin, as in Greek, the *r* appears as *l*, a very common phenomenon. So *κλέος*, for *κλέϝος*, answers exactly to *çravas*. In Latin we get *cluo, clueo*, to hear, and hence, to be called, which is also one meaning of the Greek *κλύω*, for the name one hears is the name one is called by. Κλυτός, famed, *i.e.*, heard of, which is paralleled as regards the meaning by the modern Greek *ἐξακουστός*, from *ἀκούω*, to listen. In Latin, also, we get *cli-ens* for *cluens*, a hearer, and *inclutus*, famous. In Sl. we get *sluti*, to hear; *slava*, fame; *sloves* (nom. *slovo*), a word. Lit. *szlovė*, honour, and

klau-s-aú, I hear, in which last word the *k* has been preserved intact. In Gothic we get the same root with other endings; thus *hliu-ma*, hearing; and in O. H. G. *hlût* and *hlosêm*, hear; M. H. G. *lau-schen*, listen; Dutch, *luid*, a sound, and *luid*, *loud*. In English we have not only *loud*, but *list* and *listen*, which is formed by lengthening the original root by *st*, a kind of superlative termination. So in Welsh, too, from the root *clu-* we get, with a similar addition, *clu-stiau*, the ears. You remember that in Sanscrit *çru-* for *cru-* stood in place of *clu-*. Now, it seems that in the Teutonic languages the *r*-form of the root has survived in a parallel line along with the *l*-form; for in German we have *rauschen*, to sound, beside *lauschen*, to listen; and *ruhm*, fame, beside Gothic *hliuma*, hearing: while in English we have *rustle* and *row*. Add to this Swedish and Danish *röst*, a voice. The *h* would of course fall away as well before *r* as before *l*. I will give a few instances of this. Sanscrit *kâravas*, Latin *corvus*, O. H. G. *hraben*, M. H. G. *raben*, English *raven*. All High German *b*'s between two vowels are Low German *v*'s, *e.g.*, *geben*, *give*; *streben*, *strive*; *knabe*, *knave*; etc.

In Sanscrit, *kravja-m* is raw meat; in Gothic, *hraiv*: in O. H. G., *hrêw*; in M. H. G., *rau* and *roh*; in Dutch, *rauw*; in English, *raw*. This is the root we have in Latin, *cru-or*, gore, *crudus*, raw, *cru-de-lis*, cruel; in Slav., *krŭvĭ*, gore; Lit. *kraúja-s*, blood, *krúvinas*, bloody. Take, again, ancient Greek, κρύος, frost; M. G. κρύος, cold; whence κρύσταλλος, a fixing by cold, freezing, ice; Latin, *crus-ta*; Albanian, *krü-pa*, salt, from its likeness, I suppose, to frost. To the Greek, κρυμὸς answers Old Norse *hrim*; Eng. *rime*; to Albanian *krüpa* M.H.G., *reif*, frost; and to the Latin *crusta*, our *rust*, which is only another kind of incrustation. To continue our main line of argument, that *k*, in the Ind.-G. languages generally, equals *h* in the Teutonic. Κοῖλος, in Greek, means *hollow*;

κοιλία, the *belly*; Latin, *cœlum*, Albanian, *k'iel*, the hollow or vault of heaven; this answers to our *hole*, *hollow*, the German *hohl*, and *höhle*. Now if, as seems likely enough, the German *hölle*, our *hell*, be but a shortened form pronounced rapidly, and with bated breath, with an anxious look over the left shoulder, for *höhle*, then we have the curious fact that substantially the same word means heaven in Latin, *cœlum*, and hell in English. Immanuel Swedenborg says, in one of his visions, he found many people in *hell* who fancied they were in *heaven*. This philological fact seems to add point to his experience. After all, the vault beneath us or above makes little difference. The real heaven or hell is within us, and not without.

The next consonant in our table is *g*, in Sanscrit either *g* or *g'*. This is variously modified in Zend as *gh*, *g'*, *zh*, and *z*; and in a somewhat similar manner in Sl. and Lith. But, strange to say, it regularly appears in Teutonic as *k*. Thus the root *gan-*, to beget, which we have reduplicated in Latin, *gigno*, perf. *gen-ui*, *geni-tor*, *gens*, *genus*; Greek γέγονα, γενέτωρ, γένος; S. *g'ag'ana*, *g'anitar*, *g'anas*, appears in the German *kind*; in the English, *kin*, *kindred*, and *kind*. In meaning the adjective *kind* corresponds to the Latin *gentilis*, and *generosus* in their later senses of gentle and generous. So, too, γνω in γιγνώσκω, I know; S., *g'nâ*, *g'anâmi*; Latin, *gnosco*, *gno-tio*, *gno-tus* is O. H. G., *knâw*; English, *know*. Greek, γόνυ; S., *g'anu*; Albanian, *g'ŭ*; Latin, *genu*; Zend, *zhnu*, is in German *knie*; English, *knee*. Latin *gena*; Greek γένειον, is in German *kinn*, which we palatalize to *chin*.

So *gâus* in Sanscrit, becomes *cow* in English. This is one of those exceptional cases in which an original *g* has become *b* and *β* in Latin and Greek, which gives us *bos* and βοῦς, but the modern Greek γοῦπα, as a byform of βοῦπα, *i.e.*, bull-faced, the name of a fish, preserves a relic of the ancient

form. Curiously enough, Albanian seems to follow the Teutonic languages occasionally in this respect, for not only do we get *kénun* for γενέσθαι, to become, but this very word *gâus, cow,* is in Albanian, *kāu.* Ϝέργον, in Greek (classical with loss of Ϝ,ἔργον; S., *vrag'ami,*) work; Z., *varez,* is the English *work.* S. *jugam,* Greek ζυγὸν, Latin *jugum,* Lit. *junga-s* is the English joke. The Greek ὀρέγω, modern Greek ῥέγω, which gives us the older form without the preliminary ὀ, which is only a kind of breath-taking, prefixed to many Greek words, as ὀλίγος, ὄνομα, and others, answers to the Sanscrit *urg'á-mi,* the Latin *rego, rectus,* as in *ê-rigo,* to stretch out; *porrigo,* to stretch forth; and in Dutch appears as *rekken,* our *reach;* the German *reichen.* The Greek μέγας, for μέγαλς, M. G. μεγάλος, is in Gothic *mikils,* in Scotch, *mickle.* In Albanian we get *máδ̥e,* where *g* has become dentalised to δ.

Vigil, in Latin, answers to *wake* in English. *Vegeo,* in Latin, to *wick,* Northern for *quick;* which latter form preserves an initial guttural, elsewhere lost.

That καλέω, to call, Latin *calare, calendæ,* is the same as the English *call,* seems at first sight almost more than plausible, but Grimm's Law warns us this is forbidden ground. Καλ in καλέω may be the same as *hale, e.g.,* Paul in Acts, *haling* men and women into prison; though it seems more likely that this is the same as *haul,* Dutch *halen,* German *hohlen,* to fetch, to drag; and connected with κάλως, a rope; but κλητ-εύω, κλη-τὸς, and other formations from the same root are undoubtedly the same as the Gothic (*h*) *lath-ôn;* modern German *la-den,* to invite; while *call* is the Greek γηρ- in γῆρυς; S., root *gar-, gir-nâmi,* I call; *gir* a call; *girá,* speech; Zend., *gir,* singing; Latin, *garrio, garrulus;* Albanian, *gerθite,* he called; O. H. G., *kirra;* Lit. *gársas,* voice *garzùs,* loud, *gyrà,* fame. The same root with *l* for *r* is in *gallus* for *galius,* the caller, the cock;

Albanian, *g'el'i*. The Albanian for "the cock crowed" is *kendöi g'el'i*; Latin, *cantavit gallus*. The root *can* again becomes in German, *hahn*, the singer, of which we have only the feminine, *hen*.

As we have seen while initial k = Teutonic h, k in the middle of a word sometimes = Teutonic g.

Μάκαρ has every appearance of being the same word with a different mode of declension, as μακρὸς, long. The μάκαρες θεοί were the tall gods, who stood a head and shoulders higher than any earth-born heroes. The life they lived was μάκαρ βίος, a long life. This seems the Latin *macer*, long and thin; the German *mager*, and the English *meager*. I do not think *meager* comes from the French *maigre*, though cognate with it, any more than *eager*, the Latin *acer*, comes from *aigre*. That *eager* does not come from *aigre*, I argue from the fact that the meaning diverges too widely from that of the French word. In so short a lapse of time as that hypothesis would assume, so great a disparity in sense could scarcely have arisen.

If now we proceed from γ in Greek to χ, representing an original Indo-Germanic *gh*, we enter a group of three sounds, governed by a common law, viz., all Indo-Germanic medial aspirates, namely, *gh*, *bh*, and *dh*, become in Greek their corresponding aspirate tenses, viz. χ, φ, θ; and in Teutonic remain medials, but lose the aspirate, viz., *g*, *b*, *d*. First take *gh*. Look at a word like *goose*, and the Latin *anser*. Could two words be more unlike? Scarcely, for, excepting the *s*, they have not a single sound in common; and yet they are precisely the same word. You will observe that in S, *gh* often = *h*, the simple aspirate replacing the aspirate guttural medial. The S. for goose is *hansas*; the Greek is χὴν; now, if the genitive for χὴν were χενὸς, we should know that χεν- was the stem, and the nominative χὴν stood for χένς, ς being the sign of the nominative; but the genitive is χηνός,

which then by parity of reasoning we infer stands for χενσός. Therefore, χενς-, and not χεν-, is our stem. Latin follows Sanscrit as regards the initial letter, and gives us *hanser*, the old form for *anser*, *h* being almost as evanescent a letter in Rome as it is in London. Now, as final *r* stands for *s* in Latin, we may write at once *hanses* for *anser*, which makes the Latin and Sanscrit almost identical. We have then S., *haṅsas*; Greek, χένσς; Latin, *hanses*. Now, in German, this *h* for *gh* must be *g*; and so it is, for the O. H. G., is *gans*, as is the modern German. According to our table, also, you will see that Sl. gives us *gasĭ*; Lit. *žasis*. Thus, too, Latin *hesternus* answers to German *gestern*; our *yester* in yesterday. Latin *hœdus* is English *goat*: O.H.G., *geizi*: M.H.G., *geiss*. Greek, χόρτος, a lawn, an enclosure, is Latin *hortus*; Albanian *garθ*; our *gard-en*, and also *yard*.

So, too, χράω, with the addition of *s* to the root (a common verbal addition in all Indo-Germanic languages) gives us English *graze*, in the sense of rub. χρίω, to anoint, answers to the English *grease*. Similarly χέϝω, root χυ-, answers to *gie-* in German, *giessen*, to pour; Goth., *giuta*, while our own *gush*, *gust*, *gill*, *gully*, and *gutter*, are probably different formations from the same root. This *g* in Teutonic, χ in Greek, often appears as *f* in Latin. It is hard to see the reason of this. The fact is, *f* in Latin stands for three letters in Greek, φ, χ, and θ. These letters have little in common if they be pronounced, as perhaps once they were, *p'ha*, *k'ha*, *t'ha*; but if they are sounded as the modern Greeks sound them, φῖ, θῖ, χῖ, they have a hissing sound in common.

In spite, therefore, of the common opinion, supported by the great names of *Schleicher* and *Curtius*, I believe that before the ancestors of the Romans separated from those of the Greeks, φ, θ, χ were respectively *spirants*, and no longer *explodents*. In this way we can understand their inter-

change, or occasional confusion. The Æolians said φήρ for θήρ, φλιβερός for θλιβερός, ὄρνιχα for ὄρνιθα, and the modern Greeks still confound εὐθειάζω, εὐχειάζω, θινόπωρον, χινόπωρον, θλιβερός, φλιβερός. Our children say *free* for *three*, the Albanian root for speak is θα-, while in Latin and Greek it is *fa*- φα-. But though our children say *free* for three, *fred* for *thread*, they do not say *hophouse* for *hothouse*. Is it not evident that the spirants *f*, *th*, *ch*, are more like each other than *p'h*, *t'h*, *k'h*? Anyhow, Latin *f* stands for all three, *i.e.*, for φ, θ, χ, in Greek, which means *bh*, *dh*, *gh* or *h*, respectively, in Sanscrit. Thus χολή in Greek, is *fel* in Latin; *ufel* in Albanian, *gall* in English. The χρεμ in χρεμίζειν, χρεμετίζειν, to neigh, bray, or roar, answers to *frem* in *fremere*, to roar, as the waves; *frendo* for *fremdo*, to give forth the noise *frem*; and the English *grim*, and *grumble*, German *grimm*, (subject to his own Law), *ingrimm*, wrath, *grämen*, to grieve; Sl. *grŭmĕti*, to thunder, *gromŭ*, thunder, *grimati*, sound. So the root χυ, to pour, the German *gie* in *giessen*, appears in Latin as *fu* in *fusus*, *fundo*, *fons*, *futilis*.

Χα-, the root of χαίνω, to gape, χατέω to be without, χάνω to loose, in Modern Greek, appears in Latin both as *hi*- in *hisco*, which answers very nearly in form to Greek χάσκω; and also as *fa*- in *fa-t-isco*, and *fa-mes*, wide-mouthed hunger. The same root in German and English is contained in the first two letters of *gaffen*, *gape*, *gähnen*, *yawn*.

This word is so suggestive of weariness that I must pass on to another letter. Original *dh* = θ in Greek, and *d* in the Teutonic languages; while in Latin it is often represented by *f* at the beginning of a word, mostly by *d* in the middle.

Thus θήρ in Greek is *fera* L., *deer* in English, *dier* in Dutch, *thier* in German. θυγάτηρ in Greek, is *dugitâ* S., *dughdhar*, Z., which point back to an original *dhughatar*; Lith. *dukter*; High German, *tochter*; Low German, *dochter*, our daughter.

Μῦθος, in Greek, means, properly, speech, but also counsel, plan, purpose, design. It is, I doubt not, the same as the English *mood*. The same double sense of speech and thought appears in the Welsh *meddaf*, I say, and *meddwl*, think. In German, we get *muth* in the sense of courage, but also *vermuthen*, to conjecture, *zumuthen*, to propose; whereas, in English, *moody* means at the mercy of one's mood, sullen, distraught.

So, too, Greek, θύρα, S. *dvâr* for *dhvar*, Latin *forês*, pl. Albanian *dere̥*, a gate or door; Sl. *dverĭ*, door, *dvorŭ*, doorway; Lit. *dùrys*, pl. entrance, like Latin *fores;* Gothic *daur*, English *door*; Dutch *deur;* High German *thor*, a gate, *thür*, a door. Κύθ-, the root of κεύθω, I conceal, appears in Sanscrit as *gudh-*, which from some derivatives we know has been softened from *cudh-*. As $h = \kappa$, $d = \theta$, in Low German, this must appear as *hide* and *heed* in English; and as Low German d = H. G. t, we get in M. H. G., *hüten, hut, hütte, obhut.* The Greek καθαρ-ὸς, clear, Albanian *ke̥θiele*, is the A. S. *hedar*, the M. H. G. *heitar*. Greek θάρρος, courage, answers to English *dare*. Greek θολός, mud, adjective θολερός, modern Greek θολός, muddy, answers to English *dull*, and German *toll*, which means mad. Probably *doll* is another form of *dull*; compare our own use of *dummy*. The word *dumb* itself, as we use it in dumbfounder, comes very near to the Greek θάμβος amazement. We will now go on to φ, which answers to Sanscrit *bh*, Latin *f*, German, Sclavonic, and Albanian *b*. In Old High German it appears sometimes as *p*, but I cannot help regarding the Gothic *b* as the regular and older form. Thus our English *both* is a mutilated form of the Greek ἀμφότεροι, for φὸτ is the exact equivalent of *both*, as $\theta = b$, and $\tau = th$. The Greek φρυ- in ὀφρύς, M. G., dim. φρύ-δι, Sl., *brŭvi*, S., *bhrû-bhruva*, Mod. Slovenic, *obrvi*. The Greek ὀρφανός, Latin *orbus*, is the O. H. G. *arbja*, M. H. G. *erbe*, heir, which seems to indicate

a disposition on the part of the Teutonic races to take a comforting view of bereavements. The Greek νεφέλη is Latin *nebula*,* German *nebel*, dim. from νέφος, S. *nabhas*. The Greek φώγω is the English *bake*, and as Albanian *bukë*, Phrygian βεκός, means *bread*, there seems to be some connection between this word and φαγ-εῖν, to eat. The Greek φρύγω means to dry, to roast; the Latin *frigo*, French *frier*, hence our borrowed *fry*. The S. is *bhṛg'-âmi*. Now φρυγ- has no choice but to appear in English as *brick*, which, as regards the meaning, may be compared with German *backstein*, "bakestone." So again, φηγὸς, L. *fagus*, is A. S. *boce* our *beech*, for *beec*. Latin *frag-* in *frag-mentum*, *fregi*, perf. of *frangere*, is the English *break*.

The Greek φέρω, S. *bhár-âmi*, Latin *fero*, Albanian *bar*, is English bear.

Greek φονή, φονεύω, φόνος, murder, is Gothic *banja*, wound, *bana*, murder, English *bane*. Greek φρακ-, in φράσσω, for φράκιω, Latin *farc-io*, is the German *bairga*, and our *bury*. To M. G., φαρδύς, English *broad*, I have on a former occasion referred. The Greek root φλί-, to burst, or gush forth, with its cognate forms, φλο- and φλα-, φλε, φλοι-, whence φλασμός, boasting, πα-φλάζω, to spurt or splash, ἀνα-φλύω, to well up, φλύ-σαι, to chatter, φλυαρός, chattering; Latin *fluo*, to flow, *flumen*, a stream, *fleo*, to weep, *flê-mina*, a bleeding boil, *flos*, a flower, appears with various terminations in our words, *bla-ther*, *bladder*, *blubber*, *blow*, *bloom*, *blossom*, *blood*, *and bleed*. Our *flow* has nothing to do with the Latin *fluo*, but answers to Greek πλέω, to sail.

So, again, S. *bhû-*, Greek φυ-, Latin *fu-* in *fui*, I have been, answers to Welsh *bu*, and English *be*, Goth. *bau-an*, to dwell, compare the provincial *being*. The Albanian *bota*,

* The Albanian *niegul*, doubtless, is corrupted from *niebul*, through the influence of the *l*.

the world, comes very near the S. *bhu-tis*, existence, Sl. *bùta-s*, a house. Connected are Latin *filius*, *filia*, Alb. *bir* and *biy*, son and daughter, also Greek φυλή, a race. It is, however, remarkable that Albanian seems occasionally to give us *z*, instead of *b*, for Greek φ; thus φωνή, a voice, is Albanian *zā*. Now φωτ, nom. φώ-ς in Greek, is doubtless the S. *bhávat*, being, man; but this word, *bhávat*, is used in Sanscrit, exclusively in the sense of Sir, your Honour, and this is precisely the meaning of *Zot*, in Albanian.

Take, again, the German *barm*, meaning yeast; this you get in Albanian as *brūm*, but in Latin as *ferm-* in *fermentum*, and in Greek as φύραμα. So, too, the Latin *furnus*, Alb. *furẹ*, a furnace, answers to the English *burn*, and has nothing to do with *fire*, which is the Greek πῦρ.

I will now just illustrate line 15 of the table, viz.—

Indo-Germanic *d* = S. *d*, Z. *d*, *dh*, Greek δ, L. *d*, G. *t*, H. G. *z*, *sz*, Sl. *d*, Lit. *d*, and Alb. *d* or δ.

A very good instance of this is the root *dam-*, to tame. Greek δάμνημι, δαμ-άω, δαμάζω, to tame; δάμαρ, a tamed woman, *i. e.*, a wife; δαμάλης, a tamed animal, *i. e.*, an ox. S. *dám-jâmi*, *damán-jâmi*, to tame; *damitas*, tamed; *dam-jas*, a young ox. Lat. *domare*, to tame; *domitus*, tamed; *domitor*, a tamer; *dominus* and *domina*, master and mistress. Albanian, δ*end* for δ*em-d*, tamed animals, sheep; δ*ander* for δ*amater*, the tamer, *i.e.*, the bridegroom. The same connection of ideas as far as marriage is concerned is betrayed in our own words, *bride*, *bridal*, *bridle*, and *bridewell*. The Gothic for to tame, is *ga-tamjan*; O. H. G., *zamôn*, to tame; *zami*, tame; the word, as applied to beasts, appears in M. H. G., *zahm*; English, *tame*; M. H. G., *zaum*; English, *team*, which in A. S. means *family* as well.

Δε, as a termination, means to, towards, in Greek; thus οἰκόν-δε, towards home; Zend. *da*, in *vaêçmen-da*, which translates οἰκόνδε; Lat. *do* in *endo*, *indu*, into; Albanian *ndẹ*

for Latin *endo*; Sl., *do*; Lith., *da*; English, *to*; Dutch, *te*; O. H. G., *zuo, za, ze, zi*; M. H. G., *zu*. So too, as a conjunction, or adverb, δέ, and the Albanian δέ in the compound *eδέ*, and, is the English *too*. The Greek δέ-ω is the English *tie*.

Δέμω, to build, in Greek gives us δόμος, a house; S. *damas*; Z. *dema*; Lat. *domus*; Sl. *domŭ*; Goth. *timrjan*, to build; English, *timber*; M. H. G., *zimmer*, a room, *zimmern*, to carpenter.

Δρῦ-ς in Greek is an oak, especially, but also tree in general; δρυ-μός, a grove; δένδρεον, a nazalized reduplicated form of the same word. In S. *dru-s* is wood or tree; *drumas*, a tree; Zd. *dru*, wood; Albanian, *dru*, a tree; Sl. *drěvo*, a tree.

The Greek for tooth is ὀδοὺς, gen. ὀδόντος; M. G., δόντι; Alb. *δam*; S. *dant-a-s*; Z. *dañtan*; L. *den(t)s*; Lit. *dant-i-s*; G., *tunth-u-s*; O. H. G., *zand*; Dutch, Swedish, and Danish, *tand*; English, *tooth*.

We will now pass on to Indo-Germanic *p*, of which the most remarkable point is that it invariably appears in the Teutonic languages as *f*, if it begins a word, and mostly elsewhere. A few examples must suffice. 'Απὸ Gr., *apà* S., *apa* Z., *pa* Alb. negative particle (*e. g.*, *pabes$_e$* from *pa* and *bese̥*, faith = faithless); Latin *ab, â, abs*; Goth., *af*; O. H. G., *aba.*; M. H. G., *ab*; Swedish, Danish, and Dutch, *af*; English, *of* and *off*. The Zend derivative *apa-na*, distant, explains the O. H. G., *fo-na*; M. H. G., *von*; Dutch, *van*, of, from.

'Αρπάζω for ῥαπάζω by metathesis; Latin, *rapio*; M.H.G. *raffen*; English, *reave*, p.p. *reft*. Greek, λείπω; in English, *leave*, p.p. *left*; Latin, *nepôs*; Gk. νέποδες, pl., S. *napat*, is English *nephew*; German, *neffe*. We have corrupted our form by contact with the French *neveu*, which comes straight from Lat. *nepôs*.

Greek, πατὴρ; L., *pater*; Sk., *pitâ*; (Sl., pitar); Z., *pita*; (st. *patar*), is Goth. *fadar*; O. H. G. *fatar*; English, *father*.

Greek πῶλος, the young of animals; the Latin *pullus*; the diminutive ending *-pulus* in *disci-pulus*, a son of learning, a disciple (?); the modern Greek patronymic ending -πουλος, the *son* of, as 'Ρωσσόπουλος, 'Αλεξανδρόπουλος, Χριστόπουλος, &c.; the Albanian *pūl*, she brought forth, correspond to the English *foal*. Πολὺς, many, πόλις, a state, answer to the English *full*, and *fol*-k, respectively; they both come from the same root, of which the characteristic letters are *pl* or *pr*, appearing in Greek, πίπλημι, to fill, πλῆ-θος, populace; Latin *populus*, by reduplication; *ple-bes* or *plebs*, from *pleo*, to fill; Alb. *pl'ek't*, people, multitude; German, *füllen*, to fill, *volk*, people, and *viel*, much, and many.

The Italian *paura* is the English *fear*. The first syllable, with various endings, of Latin *pau-cus*, *pau-lus*; Alb. *pak*; Greek παῦ-ρος, is the English few.

S. *pada*; Latin *pedem*; Greek πόδα, is O. H. G. *fuoz*; M. H. G. *fuss*; English *foot*.

Greek πλίνθος, a brick, is the English *flint*.

The Greek ὑπέρ, *over*, causes some difficulty. It seems to answer to S. *upari*; Z. *upairi*; Gothic *ufar*, our *over*, and High German *über* and *ober*; but the aspirate leads us from analogy to suspect, though it does not prove, that an *s* has fallen away, as in ὗς for σὺς, ἓξ for σέξ, ἕπω for σέπω, υλη for σύλη, and many more well-ascertained cases. Nevertheless, the aspirate in Greek is sometimes merely accidental; but when we look at Latin we find *super*. There is but one other language that gives us *s* in this word, and that is Albanian, which has *sipęr*. As Albanian seems to be modern Græco-italic, *i.e.*, the modern representative of the mother of Greek and Latin alike, its evidence here is most valuable, because it shows that ὑπὲρ must have had the *s*

before the Hellenic and Italic dialects divided into separate channels. Curtius suggests that *super* is, in fact, a compound preposition, standing for *insuper*, which still survives in Latin, and which would be *εἰςυπὲρ*, for *ἐνσυπὲρ*, in Greek; then, by loss of the first syllable, *συπὲρ*, and then *ὑπέρ*.

There is a perfect labyrinth of prepositions, adverbs, and conjunctions in all the Indo-Germanic languages, of which the essential element is p + vowel + r, or $p + r$ + vowel, with every conceivable modification of form and meaning: as Sanscrit *pará*, away, *param*, beyond, *puras*, before, *pari*, around, in composition, "very"; Z. *para*, before, besides, *pairi*, around, and "very." Greek *παρὰ*, beside, from *περὶ*, around, and "very"; *παρὰ* in Modern Greek, "than," and *πάρα*, very. Albanian *pȩr*, for, by, *prei*, beside, from, along with, to, *parȩ*, first, *pȩrpara*, before; Latin *per*, for, very, and through, *præ-*, before, very; Lit. *par-*, backwards, *pèr*, through. Almost all these senses come out in the English *for*, *former*, *first*, *before*, *from*, and *far*; the German *vor*, *für*, and in composition *ver-*, *e.g.*, *verbieten*, forbid, *vergessen*, to forget. The Gothic *fra-itan*, to eat up, or through, is the Latin *peredo*, and this is contracted in High German to *fressen* for *veressen*, and in English becomes *fret*. To be fretted, or, as we say, intransitively to *fret*, is really to be eaten up or eaten through. We speak of *fretting*, *i.e.*, *foreating*, care, fretting rust. "The moth fretteth the garment," albeit the moth fretteth not the garment, but only the caterpillar thereof. *Fressen*, in High German, is used exclusively of animals, and *essen* exclusively of man; I suppose, because the animal eats up everything that it finds to eat, whereas, in Germany, it was long considered a mark of good breeding, and a point of human dignity, always to leave something on the plate.

The last letter I shall notice is *t* (Indo-Germanic), which in Old Norse, Gothic, A. S., and English, appears as *th*, and

in those Low German dialects which, like the Dutch and the modern Scandinavian languages, have lost the sound of *th*, as *d* or *t*; *d* in Dutch and Platdeutsch, always; *d* in Danish and Swedish, where we pronounce as the Greek δ, as in *the*, *that*, *this*, *then*; and *t* where pronounced sharp, as Greek θ, *e.g.*, *three*, *thumb*, *thrive*, *Thursday*, *thorn*.

Thus *tu*, *te*, *tui*, in Latin; *tva*, *tvam*, *tavas*, in Sanscrit; *tûm* and *thva*, in Zend; *ti*, in Welsh; *tù*, *tavàs-is*, in Lith.; *ty*, *tvoj*, in Sl.; τούν, τὲ, τεός, in the oldest Greek; *ti*, *ta*, *teye*, in Albanian, is *thee*, *thein-s*, Gothic; *thou*, *thee*, *thine*, in English; *du* and *dein*, in M. H. G. Τέγος, in Greek, a roof, *tego*, I cover, in Latin, answer to *thatch* in English, *dak* and *decken* in Dutch, *dach* and *decken* in German. Our *deck* seems borrowed from H. G. Τρεῖς, τρία, in Greek; L. *tres*, *tria*; Zd. *thri*; Sl. *tri*, *trija*; Lit. *trys*; Alb. *tri*; is English *three*; Danish *tri*; Dutch *drie*; Flemish *drei*; German *drei*; in Gothic *threis*, *thrija*. The Latin *ton*, in *ton-itrus*, is the English *thun*, in *thunder*. *Ten-*, in *ten-vis* and *ten-er*, is our *thin*. L. *tundo*, stem *tud*, in *tu-tud-i*; S. *túd-âmi*, I strike; Alb. *u-tund*, was stricken, is *thud*, English. The *d* remaining unchanged, instead of passing into *t*, is probably due to a nazalisation of the root preserved in Latin *tundo*, and Alb. *tund*, but which has since been lost. The same thing has happened as regards the root *scid-*, to cut; Latin *scindo*, I cut; German *scheiden*. The root *tra-*, to pass through, with its various suffixes and modifications, as in Greek τρύ-ω, τι-τρά-ω, τιτραίνω, to bore; τέρετρον, a *borer*; Lat. *tero*, to bore, or wear. *Trans*, across, through, appears in English as *thr*, in *thrill*, *through*, *thrust*. Τρύφω in Greek is *thrive* in English.

Tarshas, S.; *tarsh-na*, Z., *thirst*; Latin *torreo*, for *torseo*, to parch; Greek τέρσομαι, to be dry; G. *thaurs-ja*, I thirst, *thaurstei*, thirst; Dutch *dorst*; H. G. *durst*; Danish *torst*, exhibit the same change.

The root *tal*, which we have in Greek *τλάω*, to bear; *τάλας*, enduring, suffering; *τόλμα*, endurance; S. *tôlá-jâmi*; Lat. *tollo te-tuli, tuli*, I bear, I have borne; *tlatus, latus*, borne; Sl. *tulŭ*, a quiver; *i.e.*, arrow-bearer, like Greek *τάλαρον*, a basket, is in Gothic *thul-a*, I suffer; Lowland Scotch and Old English, *I thole*; Mod. German, *dul-den*, suffer; *geduld*, patience.

I have read somewhere of an old Scotch woman expressing her disgust at read sermons in the phrase, "I canna *thole* the papper."

I think I have now taxed your patience sufficiently. In what I have laid before you there is not much that is original in the way of research, with the exception of a few conjectures, and the comparison of Albanian words. I have merely attempted to bring together some of the more striking and simple examples of Grimm's Law, in order to establish if possible the conviction in scientific minds that comparative philology is not mere guesswork, but proceeds according to law; that letters are changed, if changed at all, not anyhow but somehow. In this review I have left out of sight altogether, or merely incidentally touched on, those mutations which occur, though with more or less regularity, yet on the whole exceptionally; such as the frequent substitution of an aspirate for an initial *s*, in Greek, in Zend, and in Welsh. Neither have I dealt with those exceptions to Grimm's Law which prove the rule; as, for instance, the preservation of the letter *t* unchanged when found combined with *s*, as *stare, ἵστασθαι, stehen, stay*, and *stand*.

I have confined myself as far as possible to the positive side of the subject. And here I have preferred what is clearly ascertained to what may be plausibly conjectured. In the thorny paths of etymology it is a stable standing ground, and a firm footing to start with, which before all else is needed.

The comparative study of languages is the only path of safety from erroneous combinations. Until it was shown by this method that the Indo-Germanic family formed a group by itself, the most groundless affinities were presumed between words which had nothing in common. For instance, the Hebrew for six is *shêsh*; the Sanscrit, *shash*. How much resemblance, you will say; only a vowel's difference between them! But when we turn to Zend we find that six is *kshvas*; so here we see traces of two sounds in the Indo-Germanic numeral, first a guttural and then a labial, both of which Sanscrit has lost; but of neither of which does any Semitic tongue contain the smallest vestige. The Welsh *chwech*, six, gives us two gutturals along with a labial semi-vowel, but has lost both sibilants. The Greek ἕξ preserves the last guttural and sibilant, but changes *s* to *c*, and loses the first guttural as well as the labial semi-vowel. The Latin sex gives us sibilant + vowel + guttural + sibilant. A comparison of all these forms leads us to *ksvaks*, as a relatively primitive name for six. On the other hand, Arabic and Ethiopic give us respectively *sittuñ* and *sedestu* for six; the latter containing two dentals nowhere apparent in any Indo-Germanic form; thus the further we go back (for there can be no question that *sedestu* is an older form than *shêsh*, as its length alone would show,) the less resemblance do we find between the Semitic and the Aryan forms. It would be hard to find two words more unlike each other than *sedestu* and *ksvaks*. Hence, you see, the likeness of *shash* and *shêsh* was a mere coincidence. Just as little have *shebah*, Hebrew for seven, and English *seven* to do with one another; for seven, as we know, is the Sanscrit *saptan*. Here the Indo-Germanic form has two dentals, of which the Semitic is devoid, and the Semitic a final guttural, which the Indo-Germanic is without; in truth, the words have nothing in common but the vowels and the letter *s*. Equally

wild is the proposed identification of the Latin *Jove* with the Hebrew *Jehovah*. *Jehovah*, pointed for *Adonai*, was most likely really *Jahveh*. This is said by Semitic scholars to be a verbal adjective, from *havah*, a byeform of *hayah*, to be; the *jod* is no part of the root, but an augment or formative particle. On the other hand, *Jovis*, in Latin, stands for *Diovis*, just as *jam* stands for *diam*, *Janus* for *Dianus* the masculine of *Diana*. This *Diovis* is the Greek Ζεὺς, for Διεύς, the Sanscrit *Dyaus*, the Light, the Sky, the Sun, our own *Tues-*, in Tuesday; and has no more to do with Jehovah than the man in the moon. And yet this obsolete and utterly exploded etymology has been gravely reaffirmed only a year ago, by Professor Zerffi, Lecturer on Art at the South Kensington Museum,—as if it were not open to question. When I add that Professor Zerffi has discovered a Vedantic god, *Dipuk*, or, as he spells it, *Dypuk*, with a *y*, though why I don't know, who, he says, is a mischief-maker, and is only *Cupid* spelt backwards (!), in reckless disregard of the fact that *Cupido*, in Latin, is nothing but the substantive of *cupere*, to desire, and that words are not in the habit of spelling themselves backwards in passing from one language into another, to suit Dr. Zerffi or anyone else, you will see that there are still men in the world for whom all grammars and dictionaries have as yet been written in vain. Such monstrosities are only equalled by the attempt of an old-fashioned scholar to derive Greek from Hebrew by reading the whole language backwards. The Yorkshireman who discovered that *Plattdeutsch* was "*nobbut broad Yorkshire talked back'ards*," was a good deal nearer the truth.

EXPERIMENTS ON THE GERMINATION OF PLANTS; CHIEFLY ILLUSTRATIVE OF THE EFFECTS OF PRESSURE ON GERMINATION.

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For the past few years I have at different times made a number of somewhat desultory experiments on plants. A few of those on germination I will now lay before the Society. Some of the results surprised me, and certainly appear a little contradictory. I make no attempt to reconcile them, but simply record the facts, about the accuracy of which I am alone concerned, and for which I can vouch.

Firstly. What influence, if any, has atmospheric pressure on the germination of plants?

The following account of experiments performed will bear on this.

On September 2nd, 1878, at 7 p.m., six white mustard seeds were sown in a little moist earth, under a pressure of two atmospheres. The method adopted was as follows: A long and stout glass tube, having been hermetically sealed at one end, was then curved at about six inches from this end, until the small arm was parallel with the long and unsealed one. The seeds were then placed in a little moist earth, and floated on mercury into the smaller arm, while more mercury was poured into the longer arm, to the height of sixty inches. At 11 a.m. on the 3rd, they were much swollen, and one *appeared* to be protruding its radicle. By 1 p.m. on the 4th, the radicle was half as long as the seed itself. At 10 a.m. on the 5th, the radicles of all the six

were well protruded; and at 6.20 p.m. of the 6th, all the plants were growing vigorously.

Again, on September 3rd, 1873, at 9 p.m., three mustard seeds were sown in a similar tube, under two and two-thirds atmospheres. At 1 p.m. on the 4th, the seed most easily observed was much swollen. At 10.20 a.m. on the 5th, its radicle was slightly protruded. At 5.40 p.m. on the 5th, it was slightly longer than the seed itself; and so on from day to day till, at 5 p.m. on the 10th, the radicles of all the seeds were protruded, and the plants themselves green and growing vigorously.

I have made a number of experiments in the opposite direction, viz., by diminishing the pressure to various amounts. But here the effect in retarding, and eventually preventing, germination was very marked. Thus, on May 6th, 1873, I sowed six mustard seeds in a small pot of mould, covered by an inverted glass. At the same time I sowed six other seeds in a similar pot, covered by a similar glass, which I then partially exhausted, viz., to half an atmosphere. These latter seeds swelled, but did not germinate; the former, in two days' time, germinated completely, and soon grew into vigorous young plants.

The conditions under which the two sets were placed were exactly similar, with the exception of the difference of pressure, and of course the lesser amount of air in the former case, yet germination was rapid in the one case, but did not take place at all in the other.

But, in contrast to this, I must relate an experiment or two made in 1871. On April 18th, I sowed some seeds of *sisymbrium thalianum* and *arabis stricta*, in a glass cylinder, which I had exhausted chemically. The method, in this case, was by allowing carbonic anhydride to flow into the erect cylinder for some time, and then to invert this cylinder, the upper ground edge of which had been previously greased,

over two very small porcelain pots, in one of which the seeds were sown, while the other contained caustic potash. The inverted cylinder stood on a heavy piece of plate glass, which, after a few minutes, was pressed so closely by the external atmosphere, uncompensated within in consequence of the absorption of the contained gas by the caustic potash, that the inverted cylinder, with this plate adhering to it, could be raised without the plate becoming detached. Here I have no exact measure of the degree to which exhaustion was carried, but I believe it to have been to as great, if not to a greater, extent than in the case first described. Yet, in the course of a few days,—at noon on the 21st—the *arabis stricta*, in the glass thus exhausted, had germinated and grown (though in a very spindly fashion) half an inch in length; while a few of those of *sisymbrium thalianum* were beginning to germinate. At this time, seeds of the same species, sown at the same time in a non-exhausted vessel, were only just beginning to germinate. By 2 p.m. of the following day, the seeds of *sisymbrium thalianum* in the exhausted vessel had all sent their radicles well into the earth. But the plants had scarcely any appearance of chlorophyll, while all those in the non-exhausted vessel now began to show green cotyledons. After this, growth progressed in the plants in the non-exhausted pot, but stood still in those in the other.

If I am right in believing that the degree of exhaustion in the latter case was as great as in the former, then I think that the conclusions are fair; firstly, that different plants will germinate under different degrees of diminution of pressure, and therefore, as this factor of diminution of pressure forms an important element in the conditions which prevail as we ascend above the sea-level, at different heights above sea-level, so far as this element is concerned (of course temperature must be considered),—that white mustard

seed, for instance, could not germinate at two and three-quarter miles above the sea, because there the pressure would be diminished one-half; and that therefore, if any fossil traces of this plant should be found—a very unlikely event, it may perhaps be thought—at such a height, it will prove that the land must have been greatly elevated; and similar reasoning, founded on experiments made for each, would fix the heights above sea-level at which other plants could possibly live.

Secondly. That increase of pressure up to two and three-quarters atmospheres, and probably very far beyond, does not interfere with germination or growth, at least, in the case of the white mustard.

The following experiments, which admit of several explanations, must be mentioned here. On April 22nd, 1873, at 5.30 p.m., I sowed some seeds of *Erysimum Marshallianum*, *Iberis lagascana*, and *Cenia turbinata*, in some mould placed in a glass standing in water, beside which I placed a large test-tube, filled with a solution of pyrogallic acid in potassium hydrate, and then inserted a bell-jar over them, its mouth dipping into the water. I then sowed similar seeds, under exactly similar conditions, except that the ground and slightly greased edge of the inverted bell-jar, in this case, was pressed down on a glass surface, *i.e.*, it did not dip beneath water. In both, the oxygen was speedily removed, but of course, in the first one, with no diminution of pressure, and with plenty of aqueous vapour evolved from the surface of the water, which was driven up into the interior of the bell-jar; in the second, with an exhaustion equal to one-fifth, and the absence of a large quantity of aqueous vapour. On April 26th, the seeds in the first glass had germinated, and the plants were in vigorous growth. On the 28th, all were growing and vigorous, while those in

the drier nitrogen had not germinated in the least. Here there were two elements affecting germination; first, the loss of oxygen; second, the diminution of pressure. The loss of oxygen alone did not seem competent to prevent it. But this loss, plus the loss of moisture, and with even a slight diminution of pressure, seemed to be sufficient. The *Cenia* is a composite plant, with albuminous embryo, the others crucifers, with exalbuminous ones, the presence or absence of albumen seeming to have no effect.

May I add the result of an experiment or two as to the amount of gas evolved in germination, and on the effect of mutilating the embryo?

Firstly. To determine the quantity of CO_2 evolved.

Thus, on December 16th, 1872, I floated ten mustard seeds, wrapped in a little moist cotton-wool, into the eudiometer, the mercury in it standing at 62 m.m. In three days all ten seeds had germinated. I then introduced 27 m.m. of pure dry H., the mercury then standing at 89. I then united the gases, when the mercury fell to 67. There was a loss, therefore, of 22 measures, one-third of which was of course oxygen, *i.e.*, 7½ measures. But this is not the normal quantity of oxygen for 62 measures of atmospheric air. It should be 12·4. The differences, or 5·1 measures of oxygen, must have been consumed by the seeds in germinating. That this was the case, I proved by slipping up through the mercury a pellet of bibulous paper, soaked in solution of potash. This absorbed the CO_2, and the mercury rose about 5 m.m., sufficiently near to show that the quantity of oxygen deficient was somewhere about the same as that of the CO_2 formed. This experiment was tried again and again in various ways, and always with practically the same result.

Lastly. As to the effect of mutilating the embryo.

It is a curious question how far the integrity of the embryo is essential to the manifestation of life and growth, *i.e.*, whether each individual of the cells of which the mass constituting its substance is built up is endowed with some special power, by which, under appropriate conditions, it is able to undergo changes conventionally regarded as vital, *i.e.*, whether it can grow, form chlorophyll, beget other cells, and so on. It is known very well that among the highest animals, what are called monsters are occasionally born, such as creatures without brains, or with fewer than the normal number of limbs, etc., owing, in some cases, probably, to an original defect in the embryo itself. The analogy between the animal and vegetable embryo may not be worth much, perhaps, but it has led me to make experiments at various times; an example of which I will submit to you. I should say that they were all made with albuminous seeds, *i.e.*, with seeds whose embryo possessed a store of nutriment within the seed coat which they assimilate, and which, presumably, renders them in the earlier stages somewhat independent of food derived from the soil.

At 6.45 p.m. on the 8th of August, last year, I sowed three mutilated seeds of a species of agrostemma. One was a longitudinal section, dividing embryo and albumen into two lateral halves; the other sections were transverse, so as to procure in one the radicular, and in the other the cotyledonary extremity. At 9.30 p.m. on the 15th, all three seemed to be developing; the two small portions of the base of the cotyledons, cut off with the radicular part, had opened and enlarged, while the radicle had separated widely from the albumen (though it did not appear to have struck into the earth). The whole half of the embryo in No. 1 (*i.e.*, the lateral half) was much enlarging; and No. 3 had slightly changed, though less obviously than the others. At 11.50 a.m. on the 18th, the radicular half is described in my notes

as being very much developed, being prolonged considerably, the other two appearing the same as on the previous day. On the 18th, they had all three acquired a deep green colour; and, no further change being subsequently apparent, they were taken up and mounted, as you see them.

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